百千万人才工程

国家级人选候选人申请佐证材料

姓　　名：王　强

工作单位：浙江大学宁波理工学院

专业及组别：农业资源利用

推荐部门：宁波市

编号：10-1-038

入 选 证 书

王 强　同志：

根据《浙江省“新世纪151人才工程”（2001-2010年）实施意见》（浙组[2001]70号、浙人专[2001]277号），经各单位推荐、专家评审，并由中共浙江省委组织部、省人力资源和社会保障厅、省科技厅、省教育厅、省财政厅、省发改委、省经信委、省科协等8个部门组成的省“新世纪151人才工程”联席会议批准，您被确定为浙江省“新世纪151人才工程”第一层次培养人员。特发此证。

浙江省“新世纪151人才工程”联席会议办公室

浙江省新世纪151人才工程联席会议办公室

二〇一〇年 年十二月二十一日

荣誉证书

HONORARY CREDENTIAL

王　强　同志：

在农业科技成果转化及推广工作中，成绩显著，获“2011年度浙江省农业科技成果转化推广奖”，特发此证，以资鼓励。

浙江省人民政府

二〇一二年九月

荣誉证书

证字第2013013号

授予 王 强 同志宁波市有突出贡献专家荣誉称号。

宁波市人民政府

二〇一三年十二月

浙江省科学技术奖

证　书

为表彰浙江省科学技术奖获得者，特颁发此证书。

项目名称：植物次生代谢物生物合成机理及高效提取制备的关键技术开发与应用

奖励等级：**三等**

获 奖 者：浙江大学宁波理工学院(第一完成单位)
王　强、郑赞胜、阮　晓、骆成才、
危　凤、刘　本、靳　挺

浙江省人民政府

二〇一〇年

证书号：1003219－1

宁波市科学技术奖

证　书

为表彰宁波市科学技术奖获得者，特颁发此证书。

项目名称：药用植物高效利用研究与应用

奖励等级：二等

获 奖 者：浙江大学宁波理工学院（第一完成单位）

王　强　郑赞胜　阮　晓　骆成才　危　凤
刘　本　张莺莺　陈　维　江海亮　陈令武

二〇一〇年一月

证书号：090205-1

二-3-25
√ 12902

国家自然科学基金资助项目批准通知

浙江大学宁波理工学院 科研处转 王强 同志：

经同行专家评议、评审，国家自然科学基金委员会批准资助您的申请项目。请您登录国家自然科学基金委员会信息系统（http://isis.nsfc.gov.cn），获取《国家自然科学基金委员会资助项目计划书》（以下简称计划书）。（**国家自然科学基金委员会以电子邮件方式将登录系统的用户名和密码发送到申请者在申请书中填写的电子邮箱**）。

请您按照本通知的研究期限、资助金额和修改意见填写计划书，要求纸质原件（一式两份）和电子文档同时报送。原件送所在单位审核盖章后，由单位在 10 月 25 日之前统一寄至我科学部；电子文件由申请者上载到国家自然科学基金委员会信息系统（http://isis.nsfc.gov.cn），或用电子邮件发送到：report@pro.nsfc.gov.cn。如对批准意见有异议，须在上述日期前提出，未说明理由逾期不报者，视为自动放弃接受资助。请保证纸质原件和电子文档内容一致。

国家自然科学基金委员会
生命科学部
2004 年 9 月 22 日

附：批准意见表

项目批准号	30470330	归口管理部门	生命科学部	资助领域分类代码	C011108
项目名称	红景天(R rosea. L)种内遗传多样性与分子适应机制研究				
资助类别	面上项目	亚类说明	自由申请项目		
附注说明					
项目负责人	王强	依托单位	浙江大学宁波理工学院		
资助金额	20 万元	研究期限	2005 年 01 月 至 2007 年 12 月		

对研究方案的修改意见：

建议进一步将不同生境对次生代谢物质积累机理的影响机制要有深入的研究设计和机理揭示。

31501401－182－1

国家自然科学基金资助项目批准通知

浙江大学宁波理工学院　王强同志：

根据《国家自然科学基金条例》的规定和专家评审意见，国家自然科学基金委员会决定资助您的申请项目。请您登录科学基金项目管理 ISIS 网络信息系统（https://isis.nsfc.gov.cn），获取《国家自然科学基金资助项目研究计划书》（以下简称计划书）。您登录该系统的用户名和密码以电子邮件方式发送至您在申请书中填写的电子邮箱。

请您按照本通知的研究期限、资助金额和修改意见填写计划书，要求纸质原件（一式两份）和电子文档同时报送（请保证电子文档和纸质文件内容一致）。电子文档由申请者上传到科学基金网络信息系统（https://isis.nsfc.gov.cn），或用电子邮件发送到：report@pro.nsfc.gov.cn 信箱，电子文档报送截止日期为 9 月 25 日 ；纸质原件送所在单位审核盖章后，由依托单位在 9 月 28 日前统一报送；如对批准意见有异议，须在上述日期前提出；未说明理由逾期不报计划书者，视为自动放弃接受资助。

国家自然科学基金委员会

生命科学部

2007 年 9 月 5 日

附：批准意见表（见背面）

附：批准意见表

项目批准号	30770334	归口管理部门	生命科学部	资助领域分类代码	C011101
项目名称	加拿大一枝黄花（Solidago Canadensis L)入侵过程的化学生态机制研究				
资助类别	面上项目	亚类说明	自由申请项目		
附注说明					
项目负责人	王强	依托单位	浙江大学宁波理工学院		
资助金额	30.00 万元	研究期限	2008.01 至 2010.12		
对研究方案的修改意见：					

附件：项目评审意见及修改意见表

项目批准号	31670631	项目负责人	王强	申请代码1	C160701
项目名称	DHAP诱导天山云杉自毒作用发生的分子机制研究				
资助类别	面上项目		亚类说明		
附注说明	常规面上项目				
依托单位	浙江大学宁波理工学院				
直接费用	62.00 万元		起止年月	2017年01月 至 2020年12月	

通讯评审意见：

<1>自毒作用是化学生态中的重要领域，也是一个研究热点。申请者从分子层面开展研究，对揭示植物自毒作用的内部响应机制具有重要意义，其学术思想具有一定的创新性，申请者的研究基础也较扎实。但是，申请者的研究方案设计的偏庞大，研究内容偏多，主题不够集中，深度不足。

建议：不宜资助。

建议：申请者修改研究内容集中一个分子学的方向深入探讨，明年再报。

<2>天山云杉是我国新疆地区天山山地地带性森林植被建群种，但有关研究表明存在天然更新障碍，成为森林经营管理中的一大难题，直接影响着天山云杉林的天然更新和可持续经营。针对其天然更新障碍，有学者提出了“天山云杉更新障碍的自毒作用”假说，并初步明确了DHAP是主要的自毒物质及其发生自毒作用的浓度差异。本项目从DHAP诱导天山云杉自毒作用发生的浓度差异性生理生态表象入手，试图通过蛋白质组和转录组等组学技术，明晰自毒作用发生的分子调控网络，对于揭示天山云杉更新障碍问题的内在分子机制具有重要意义。本项目研究思路新颖，研究内容适当，关键问题选择准确，研究方法可行，总体研究方案合理，有良好的前期相关研究基础，主持人具有较强的研究能力，实验条件具备。建议优先资助。

<3>1、植物化感作用是植物生态系统中最重要的生态生理过程机制。化感作用影响森林生态系统的演替，影响森林更新和林木生长，探讨化感作用对天山云杉更新的影响机制，对该树种的森林培育和资源保护及可持续经营具有重大意义。

2、申请人针对植物化感作用机制问题有比较全面的把握，所提出的科学问题准确且有一定深度，研究内容规划合理，研究方案可行。

3、申请人前期研究磁基础较好，研究团队及实验研究条件较好，能确保本项目的顺利完成。

4、经费预算：（1）既然是送测样品，就根据研究需要确定样品数量、单个样品测试费及总额，无需具体说明生物技术公司的每道工序费用；（2）样品送测的差旅费预算过多。

对研究方案的修改意见：

生命科学部

2016年8月17日

molecules

MDPI

Review

Response of Plant Secondary Metabolites to Environmental Factors

Li Yang, Kui-Shan Wen, Xiao Ruan, Ying-Xian Zhao, Feng Wei and Qiang Wang *

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Academic Editors: Helen D. Skaltsa and Marina Sokovic

Received: 11 February 2018; Accepted: 23 March 2018; Published: 27 March 2018

check for updates

Abstract: Plant secondary metabolites (SMs) are not only a useful array of natural products but also an important part of plant defense system against pathogenic attacks and environmental stresses. With remarkable biological activities, plant SMs are increasingly used as medicine ingredients and food additives for therapeutic, aromatic and culinary purposes. Various genetic, ontogenic, morphogenetic and environmental factors can influence the biosynthesis and accumulation of SMs. According to the literature reports, for example, SMs accumulation is strongly dependent on a variety of environmental factors such as light, temperature, soil water, soil fertility and salinity, and for most plants, a change in an individual factor may alter the content of SMs even if other factors remain constant. Here, we review with emphasis how each of single factors to affect the accumulation of plant secondary metabolites, and conduct a comparative analysis of relevant natural products in the stressed and unstressed plants. Expectantly, this documentary review will outline a general picture of environmental factors responsible for fluctuation in plant SMs, provide a practical way to obtain consistent quality and high quantity of bioactive compounds in vegetation, and present some suggestions for future research and development.

Keywords: plant secondary metabolites; phenolics; flavonoids; terpenoids; alkaloids; responses; environmental factors; light irradiation; temperature; soil water; soil fertility and salinity

1. Introduction

As distinguished from primary metabolism and first attributed to Kossel [1], plant secondary metabolism is defined as a term for pathway and small molecule products of metabolism that are non-essential for the survival of the organism. In nature, a variety of secondary metabolism pathways elicited an array of plant defensive compounds called secondary metabolites (SMs). In addition to basic nutrients such as proteins, fats or carbohydrates, plants can produce other compounds including taxoids, polysaccharides, flavones, etc. SMs are the molecules to be dispensable for plant metabolism and growth, whereas the wide variety and high diversity of secondary products are key components for plants to interact with the environment in the adaptation to both biotic and abiotic stress conditions [2,3]. In fact, secondary metabolites involved in the protection against herbivores, bacteria, fungi, viruses and even other competing plants. In addition, some plants made use of secondary metabolites as signals for communication between plants and symbiotic microorganisms, as well as served to attract pollinators and seed dispersers [3,4].

Plant SMs are usually classified according to their chemical structure [5]. Several groups of large molecules, including phenolic acids and flavonoids, terpenoids and steroids, and alkaloids have been implicated in activation and reinforcement of defense mechanisms in plants (see the classification and biosynthisis of flavonoids, alkaloids and terpenoids in plant at Figures 1–3) [5,6]. Due to their

Industrial Crops & Products 111 (2018) 755–767

Contents lists available at ScienceDirect

Industrial Crops & Products

journal homepage: www.elsevier.com/locate/indcrop

Synthesis and herbicidal activity of 4, 8-DHT and its derivates

Jian-hong Zhang[a,d], Li Yang[a], Xiao Ruan[a], Zhe-liang Sheng[b], Min-fen Yu[c], Bing-song Zheng[e], Jin-yun Zhang[a], Xian-xian Li[a], Ying-xian Zhao[a], Qiang Wang[a,*]

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A R T I C L E I N F O

Keywords:
4, 8-DHT
Derivates
Synthesis
Phytotoxic activity
Weeds
Seed germination
Seedling growth

A B S T R A C T

The chemosynthesis and potential as green herbicides of 4,8-dihydroxy-1-tetralone (4, 8-DHT) and its derivates were emphatically addressed in this study. Firstly, the synthesis of 4, 8-DHT from commercially available material 1, 5-dihydroxynaphthalene was carried out through a novel route of five reaction steps. Then, its five derivates including 4-benzoyl-8-hydroxy-1-tetralone, 4-(3-hydroxypropoxy)- 8-hydroxy-1- tetralone, 4-(2,3-dihydroxypropoxy)-8-hydroxy-1-tetralone, 4-hydroxy-8-(3-hydroxy propoxy) −1-tetralone and 4-hydroxy-8-(2,3-dihydroxypropoxy)-1- tetralone were prepared by modifying alcoholic and phenolic hydroxyl in C-4 and C-8 position of 4,8-DHT molecular structure. After that, these synthesized compounds were examined for their toxicity against six kinds of weeds (*Lolium perenne*, *Phalaris arundinacea*, *Elymus dahuricus*, *Cichorium intybus*, *Sorghum sudanense*, and *Trifolium repens*) *in vitro*. In general, high concentration could generally inhibit while low concentration might promote the growth of weeds. Among these compounds, 4-(3-hydroxypropoxy)-8 −hydroxy-1-tetralone and 4-hydroxy-8- (3-hydroxypropoxy) −1-tetralone showed significant phytotoxic activities against the six tested weeds, while 4-hydroxy-8-(2,3-dihydroxypropoxy) −1-tetralone was less toxic. For all the six tested weeds, *E. dahuricus* appeared the most sensitive to the treatments of 4, 8-DHT compounds. Hence, it has been suggested that variables including compound type and concentration as well as weed species should be seriously considered in order to develop and utilize the group of 4, 8-DHT compounds as herbicide in future.

1. Introduction

As one of natural chemicals, 4,8-dihydroxy-1-tetralone (4, 8-DHT) was first isolated from a *Scytalidium* species (Findlay and Kwan, 1973), and subsequently this chiral compound in racemic form found in several fungi and plants (Machida et al., 2005; Wu et al., 2011; Li et al., 2014a, 2014b). The two enantiomers of 4, 8-DHT were identified as (−)-(4*R*)-4,8-DHT and (+)-(4*S*)-4,8-DHT, commonly named as regiolone and isosclerone, respectively (Machida et al., 2005; Liu et al., 2007). Recent studies demonstrated some biological properties of 4, 8-DHT, including toxicity to plants (Ciniglia et al., 2012) and cytotoxicity to human cancer cells (Wu et al., 2011; Klaiklay et al., 2012; Salimi et al., 2014; Li et al., 2014a, 2014b). Lately, we also found that 4, 8-DHT isolated from *Carya callicarpa* epicarp could exhibit some dosage-dependent stimulation or inhibition effect on several plant species with of horticultural interests (Li et al., 2014a, 2014b). Besides, an analysis of the phytotoxicity indicated that isosclerone was more toxic to some selected horticultural species than regiolone or racemic 4, 8-DHT (Yang et al., 2016). Based on our previous investigation, the allelochemical 4, 8-DHT seems to have the potential as a natural herbicide (Li et al., 2014a, 2014b; Yang et al., 2016).

Up to now, the solvent extraction method has been widely used to separate 4, 8-DHT from plant species in *Juglans* genus. However, the yield of product provided by traditional method was low, and the process of extraction and purification was complicated (Machida et al., 2005; Li et al., 2014a 2014b). Due to the inevitable trend of artificial synthesis (Beshkar et al., 2017; Razi et al., 2017; Zinatloo-Ajabshir et al., 2017a; Zinatloo-Ajabshir et al., 2017b; Zinatloo-Ajabshir and Salavati-Niasari, 2017), some efforts to synthesize 4, 8-DHT have been made in recent years.

In one study, the 4, 8-DHT was obtained by reduction of juglone (5-hydroxy-1,4-naphthalenedione) with $LiAlH_4$ (lithium aluminium hydride) in THF (tetrahydrofuran), and at the same time, the mixture of sclerone (3,4-dihydro- 4,5-dihy- droxynaphthalen-1(2H)-one) was also

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https://doi.org/10.1016/j.indcrop.2017.11.051
Received 15 September 2017; Received in revised form 24 November 2017; Accepted 27 November 2017

Journal of CO_2 Utilization 18 (2017) 283–293

Contents lists available at ScienceDirect

Journal of CO_2 Utilization

journal homepage: www.elsevier.com/locate/jcou

Extraction of total alkaloids, peimine and peiminine from the flower of *Fritillaria thunbergii* Miq using supercritical carbon dioxide

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ARTICLE INFO

Article history:
Received 21 September 2016
Received in revised form 30 January 2017
Accepted 30 January 2017
Available online xxx

Keywords:
Fritillaria thunbergii Miq
Supercritical fluid extraction
Central composite design
Total alkaloids
Antioxidant activities
Peimine
Peiminine

ABSTRACT

This study for the first time designed to use supercritical fluid extraction (SFE) to extract total alkaloids, peimine and peiminine from the flower of *Fritillaria thunbergii* Miq. 2,2′-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid) diammonium salt radical cation scavenging activity (ABTS-RSA) and ferric reducing antioxidant potential (FRAP) assay were selected to evaluate the antioxidant capacity of the extracts. A central composite design (CCD) with four variables (extract time (1.5–3.5) h, temperature (50–70) °C, pressure (15–35) MPa and co-solvent (ethanol: water) ratio (80–100, v/v) %was employed for optimization of process parameters, and response surface plots were constructed in accordance with a second order polynomial model. The highest yields of total alkaloids (2.9 mg/g), peimine (0.7 mg/g) and peiminine (0.07 mg/g) were predicted at optimal conditions of 2.9 h, 61.3 °C, 30.6 MPa and 90.3% ethanol and the antioxidant activity of the extracts was estimated to be comparable to that of α-tocopherol with ABTS value of 0.5 mg/mL and FRAP value of 658 mg AAE/100 g, respectively. These results suggest that optimization of the extraction conditions is critical for accurate quantification of total alkaloids, peimine and peiminine, and antioxidants in *F. thunbergii* Miq flower, which may further be used for industrial extraction procedure.

1. Introduction

Fritillaria isone of the largest genera belong to family of Liliaceaeplants. Many species of *Fritillaria* were widely used in traditional folk medicine in China, Japan and Turkey. Besides, the bulbs of *Fritillaria* species grown in China have been used as antitussive and expectorant herbs in Traditional Chinese Medicine (TCM) for over two centuries, such as *Fritillaria thunbergii* Miq. (Chinese name Zhe Beimu) being the first one from genus *Fritillaria*. Pharmacological analyses of various extracts and pure compounds isolated from different *Frittillaria* species including *F. thunbergii* demonstrated peimine (verticine *N*-oxide 1) and peiminine (verticinone N-oxide-2) (Fig. 1) as the major cevanine type of isosteroidal alkaloids with characteristic structure of hexacyclic benzo (7, 8) fluoreno (2, 1-b) quinolizine nucleus, which existed in different *Fritillaria* species and were the primary active ingredients responsible for the antitussive activity[1,2]. Most previous studies of *F. thunbergii* concentrated on the bulbs rather than other parts due to the traditional and customary use of this plant [3]. Propagation of *F. thunbergii* seed has very little value of practical application because the growth of seedlings is too weak and the development of bulbs is so slow as to take 5–6 years to grow into apparent size. In production practice of *F. thunbergii*, shoot apex can induce adult-bulb (five-year old) to produce two bulb-lets per year for commercial use [4]. In the reported study of the chemical constituents of *F. Thunbergii* flower, eight compounds were isolated and identified [3]. So far, there was few investigations on the extraction of alkaloids from the flower of *F. thunbergii*. The first attention of this work is to explore an effective method for extraction of main active ingredients from *F. Thunbergii* flower which can provide some technical support for the development of new resources food.

Supercritical fluid extraction (SFE) technology has been widely applied in different fields, such as food science, natural products, by-product recovery, pharmaceutical and environmental sciences, due to the mian advantages including reduction of extraction time, solvent-free analytes, being suitable for thermo-sensitive compounds, production of cleaner extracts and environmental friendly [5]. Although some works on the SFE of alkaloid [6–8] and antioxidant components [9–11] have been published, the SFE of alkaloids from the flower of *F. Thunbergii* remains to be elucidated. As known, the main drawback of supercritical CO_2 with low polarity is difficult to extract high polar components. However,

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http://dx.doi.org/10.1016/j.jcou.2017.01.024
2212-9820/

PLOS ONE

RESEARCH ARTICLE

Physiological effects of autotoxicity due to DHAP stress on *Picea schrenkiana* regeneration

Li Yang[1,2], Xiao Ruan[1], Dean Jiang[2], Jianhong Zhang[3], Cunde Pan[4], Qiang Wang[1]*

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Citation: Yang L, Ruan X, Jiang D, Zhang J, Pan C, Wang Q (2017) Physiological effects of autotoxicity due to DHAP stress on *Picea schrenkiana* regeneration. PLoS ONE 12(5): e0177047. https://doi.org/10.1371/journal.pone.0177047

Editor: Wujun Ma, Murdoch University, AUSTRALIA

Received: November 7, 2016

Accepted: April 23, 2017

Published: May 8, 2017

Data Availability Statement: All relevant data are within the paper and the Supporting Information file.

Funding: This work was supported by Natural Science Foundation of China (NSFC, 31670631) and Preferential Foundation for Postdoctoral Research Project of Zhejiang (20300586201). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

Abstract

Picea Schrenkiana as one of the most important zonal vegetation was an endemic species in Middle Asia. Natural regeneration of *P*. *Schrenkiana* is a long existing problem troubling scientists. The autotoxicity of 3,4-dihydroxy-acetophenone (DHAP) was found to be a causative factor causing the failure of *P*. *Schrenkiana* natural regeneration. The effects of concentrations of DHAP treatment on the viability of root cell, activities of antioxidant enzymes and levels of *P*. *Schrenkiana* phytohormones were performed to disclose the physiological mechanism of DHAP autotoxicity. It was observed that high concentration of DHAP could inhibit the seed germination and seedling growth, but had a hormesis at low concentrations. Analyses showed that the root cells significantly lost their viability treated with high DHAP. The enzymes activities of seedlings were significantly stimulated by the treatment of 0.5 mM DHAP to give a transient increase and then decrease as DHAP concentration increased to 1.0 mM except for GR (glutathione reductase) in which DHAP treatment had little effect on its activity. Comparing with the control, an increase in the levels of phytohormones ZT (zeatin), GA_3 (gibberellic acid) and IAA (indole acetic acid) was induced by the treatment of DHAP at low concentrations (0.1±0.25 mM), but the significant deficiency was found treated by high concentrations (0.5±1.0 mM). In addition, the ABA (abscisic acid) level increased in all experimental observations. These results suggested that DHAP significantly affected indices of growth and physiology, and provided some new information about different effect in *P*. *Schrenkiana* treated with DHAP.

Introduction

Plant recruitment plays a central role in plant population and dynamic communities [1]. Plant recruitment can be influenced by several parameters including light, nutrients, water, understory vegetation or predation [2–4], and also by the chemically mediated interferences (allelopathy) [5]. Higher plants generally release one or more bioactive chemicals into the environment that interact between plants with either stimulatory or inhibitory influences, i.e. a

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Seasonal Dynamics of Metabolites in Needles of *Taxus wallichiana* var. *mairei*

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Academic Editor: Derek J. McPhee
Received: 7 September 2016; Accepted: 16 October 2016; Published: 20 October 2016

Abstract: Seasonal variations of the phytochemicals contents in needles of *T. wallichiana* var. *mairei* due to the effects of growth meteorological parameters were investigated in this study. The needles of *T. wallichiana* var. *mairei* were collected from different months and the contents of taxoids (paclitaxel, 10-deacetylbaccatin III (10-DAB), baccatin III, cephalomannine, 10-deacetyltaxol (10-DAT)), flavones (ginkgetin, amentoflavone, quercetin) and polysaccharides were quantified by ultra performance liquid chromatography (UPLC) and the resonance light scattering (RIL) method. The content of taxoids gave the highest level of 1.77 ± 0.38 $mg \cdot g^{-1}$ in January, and the lowest value of 0.61 ± 0.08 $mg \cdot g^{-1}$ in September. Unlike taxoids, the content of flavonoids was the highest in August. The content of polysaccharides reached peak value of 28.52 ± 0.57 $mg \cdot g^{-1}$ in September, which was two times higher than the lowest content of 9.39 ± 0.17 $mg \cdot g^{-1}$ in January. The contents of paclitaxel, 10-DAB, 10-DAT and polysaccharides significantly depended on meteorological parameters. The mean of minimum temperature (R = −0.61) and length of daylight (R = −0.60) were significantly correlated to 10-DAB content, while 10-DAT level showed significant correlation with length of daylight (R = −0.70) and relative humidity (R = 0.70). In addition, temperature had significantly negative effect on the content of paclitaxel and a significantly positive effect on that of polysaccharides. This study enriched the knowledge on the accumulation pattern of metabolites and could help us to determine the collecting time of *T. wallichiana* var. *mairei* for medicinal use.

Keywords: *Taxus wallichiana* var. *mairei*; metabolites; seasonal dynamics; meteorological parameters

1. Introduction

Taxus wallichiana var. *mairei*, also known as the Chinese yew belonging to the Taxaceae family, is a protected, valuable and natural anti-cancer plant endemic to China [1]. The extracts of the plant have been commonly used in traditional Chinese medicine for cancer treatment [2–4]. As one of the most broad-spectrum anticancer agents, paclitaxel has been proved to have a remarkable effect against breast, lung, blood, and ovarian cancers [5–7]. Since the discovery of paclitaxel with its significant anticancer biological activity in the bark of *T. wallichiana* var. *mairei*, extensive efforts have been taken to identify other members of the taxoids group exhibiting potential anti-tumor activities. In relation to this, 10-DAB and baccatin III as paclitaxel precursors can be converted to paclitaxel or taxotere, a chemically modified analogue with more efficient anti-cancer activity than paclitaxel [8]. Thus far, more than

Ecology and Evolution

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Effects of climate warming on plant autotoxicity in forest evolution: a case simulation analysis for *Picea schrenkiana* regeneration

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Keywords
Climate warming, DHAP, *Picea schrenkiana*, plant autotoxicity, seed germination, seedling growth.

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Funding Information
Natural Science Foundation of China, (Grant/Award Number: "30360087, 30960313").

Received: 13 October 2015; Revised: 13 June 2016; Accepted: 27 June 2016

***Ecology and Evolution* 2016; 6(16): 5854–5866**

doi: 10.1002/ece3.2315

Abstract

In order to explore how plant autotoxicity changes with climate warming, the autotoxicity of *P. schrenkiana* needles' water extract, organic extract fractions, and key allelochemical DHAP was systemically investigated at the temperature rising 2 and 4°C based on the data-monitored soil temperature during the last decade in the stage of Schrenk spruce regeneration (seed germination and seedling growth). The results showed that the criterion day and night temperatures were 12°C and 4°C for seed germination, and 14°C and 6°C for seedling growth, respectively. In the presence of water extract, the temperature rise of 2°C significantly inhibited the germination vigor and rate of *P. Schrenkiana* seed, and a temperature rise of 4°C significantly increased the inhibition to the seedling growth ($P < 0.05$). Among the three organic fractions, the low-polar fraction showed to be more phytotoxic than the other two fractions, causing significant inhibitory effects on the seed germination and growth even at low concentration of 0.1 mg/mL, and the inhibition effect was enhanced as temperature increased. The temperature rise significantly enhanced the promotion effect of DHAP, while the inhibition effect of temperature rise became less important with increasing concentration of DHAP. This investigation revealed that autotoxicity of *P. schrenkiana* was affected by the climate warming. As expected, it provided an insight into the mechanism and effectiveness of allelopathy in bridging the causal relationship between forest evolution and climate warming.

Introduction

The phenomenon of one plant's growth inhibited by chemicals released from another plant into environment is generally defined as allelopathy (Callaway and Vivanco 2006). The term "allelopathy" was first used by Hans Molisch from a physiological perspective to describe the effect of ethylene on fruit ripening (Duke 2010). Allelochemicals, delivered through decomposition, volatilization, leaching, and root exudation (El Mehdawi et al. 2011), play an important role in the distribution of plant populations (Wardle et al. 2011), the succession of communities, as well as the nutrient chelation (Vanderstukken et al. 2014), and were also suggested as a mechanism driving exotic plant invasion (Mangla and Callaway 2008). In spite of usually being interspecific, allelopathy may also occur within the same species the so-called autotoxicity. Up to now, autotoxicity has been documented in a number of coniferous species and believed to be involved in natural and managed ecosystems (Fernandez et al. 2008).

Although it is still under debate whether and how allelopathy drive forest succession, ecosystem-level alleopathic effect has been argued as a cause for regeneration failure of conifer, evidenced by examples from sitka spruce, scots pine, norway spruce, black spruce, red pine,

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Enantioselective Separation of 4,8-DHT and Phytotoxicity of the Enantiomers on Various Plant Species

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Academic Editor: Derek J. McPhee
Received: 23 March 2016; Accepted: 19 April 2016; Published: 22 April 2016

Abstract: As a candidate for bioherbicide, 4,8-dihydroxy-1-tetralone (4,8-DHT) was isolated from *Caryospora callicarpa* epicarp and its two enantiomers, *S*-(+)-isosclerone and *R*-(−)-regiolone, were separated by chiral high-performance liquid chromatography (HPLC) on a Chiralcel OD column with chiral stationary phase (CSP)-coated cellulose-tris(3,5-dimethylphenylcarbamate). Then, the phytotoxicity of 4,8-DHT and its enantiomers toward the seeds germination and seedling growth of the five tested plant species, including lettuce (*Latuca sativa*), radish (*Raphanus sativus*), cucumber (*Cucumis sativus*), onion (*Allium cepa*), and wheat (*Triticum aestivum*), were investigated and the results indicated a hormesis at low concentration of 4,8-DHT and its enantiomers, but a retardant effect at high concentration. Between the two enantiomers of 4,8-DHT, the *S*-(+)-isosclerone was more toxic to seeds germination and seedling growth of the five tested plant species than the *R*-(−)-regiolone, and also the phytotoxicity of *S*-(+)-isosclerone varied with different plants. For example, *S*-(+)-isosclerone was the most active to seedling growth of lettuce, indicating that *S*-(+)-isosclerone had specific effects on different organisms. Thus, all of the chirality and concentration of 4,8-DHT, as well as the affected plant species, need to be taken into consideration in the development and utilization of 4,8-DHT.

Keywords: 4,8-dihydroxy-1-tetralone (4,8-DHT); chiral-selective separation; enantiomers; phytotoxicity

1. Introduction

Chirality of a pair of molecules with a non-superposable mirror image is almost caused by the presence of an asymmetric carbon atom. Chiral molecules are widely used as the mainstay of pesticides. As many as 25% of all pesticide active ingredients are chiral, existing as two mirror images called enantiomers [1]. For economic reasons, chiral pesticides are primarily used as a mixture of enantiomers or racemates [2]. *In vivo*, although the enantiomers of chiral pesticides have identical physical and chemical properties, they usually display different physiochemical and biochemical properties in metabolism, excretion, side effects, and toxicity, even acting as an antagonist [3–5]. One enantiomer of a chiral pesticide may have the desired effects on a target species, whereas the other enantiomer may not [2]. In recent years, the enantioselective behavior of chiral pesticides has received more attention at the forefront of chemistry and toxicology research [6–8]. It was reported that the enantiomers of many chiral pesticides showed different activity. For example, the toxicity to *Daphnia* revealed that the (−)-enantiomer of leptophos showed a lower toxicity than its (+)-form and racemic form [9]; (+)-fenamiphos proved be about 20 times more toxic to *Daphnia* than (−)-fenamiphos [10];

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Optimization of Supercritical Fluid Extraction of Total Alkaloids, Peimisine, Peimine and Peiminine from the Bulb of *Fritillaria thunbergii* Miq, and Evaluation of Antioxidant Activities of the Extracts

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Academic Editor: Carlos Manuel Silva

Received: 31 March 2016; Accepted: 24 June 2016; Published: 29 June 2016

Abstract: Supercritical fluid extraction (SFE) was used to extract total alkaloids, peimisine, peimine and peiminine from the bulb of *Fritillaria thunbergii* Miq. The antioxidant capacity of the extracts was evaluated by DPPH radical scavenging activity (DPPH-RSA), ABTS radical scavenging activity (ABTS-RSA) and ferric reducing capacity (FRAP) assay. A central composite design (CCD) with four variables and five levels was employed for optimization of process parameters, and response surface plots were constructed in accordance with a second order polynomial model. Under optimal conditions of 3.0 h, 60.4 °C, 26.5 MPa and 89.3% ethanol, the highest yields were predicted to be 3.8 mg/g for total alkaloids, 0.5 mg/g for peimisine, 1.3 mg/g for peimine and 1.3 mg/g for peiminine, and the antioxidant capacity of extracts displayed $EC_{50,\ DPPH}$ value of 5.5 mg/mL, $EC_{50,\ ABTS}$ value of 0.3 mg/mL and FRAP value of 118.2 mg ascorbic acid equivalent (AAE)/100 g.

Keywords: *Fritillaria thunbergii* Miq; supercritical fluid extraction; central composite design; total alkaloids; peimisine; peimine; peiminine; antioxidant capacity

1. Introduction

Fritillaria is a genus of 130–165 species [1,2] within the monocot family Liliaceae, and is native to temperate regions of the Northern Hemisphere [3]. The bulbs of *Fritillaria* species growing in China have been used as antitussive and expectorant herbs in Traditional Chinese Medicine (TCM) for more than 200 years, *Fritillaria thunbergii* Miq. (Chinese name Zhe Beimu) being the first one from genus *Fritillaria* [4]. Alkaloids, as the main active ingredients, contribute to the antitussive and expectorant function and they are usually extracted by classical solvent extraction [5,6]. According to Chinese Pharmacopeia (2010 edition), the content of peimine and peiminine in the bulb of *F. Thunbergii* extracted by the $CHCl_3/CH_3OH$ = 4:1 and analyzed by HPLC must be higher than 0.1% for medical use (chemical structure of peimisine, peimine, and peiminine see Figure 1) [7]. However, solvent extraction is time-consuming and also causes some damages to the environment and health.

Molecules **2014**, *19*, 15452-15467; doi:10.3390/molecules191015452

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ISSN 1420-3049

www.mdpi.com/journal/molecules

Article

Phytotoxicity of 4,8-Dihydroxy-1-tetralone Isolated from *Carya cathayensis* Sarg. to Various Plant Species

Xian-Xian Li [1,2], Min-Feng Yu [1], Xiao Ruan [1], Yu-Zhu Zhang [1] and Qiang Wang [1,2,*]

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External Editor: Derek J. McPhee

Received: 19 August 2014; in revised form: 15 September 2014 / Accepted: 16 September 2014 / Published: 26 September 2014

Abstract: The aqueous extract from *Carya cathayensis* Sarg. exocarp was centrifuged, filtered, and separated into 11 elution fractions by X-5 macroporous resin chromatography. A phenolic compound, 4,8-dihydroxy-1-tetralone (4,8-DHT) was isolated from the fractions with the strongest phytotoxicity by bioassy-guided fractionation, and investigated for phytotoxicity on lettuce (*Latuca sativa* L.), radish (*Raphanus sativus* L.), cucumber (*Cucumis sativus* L.), onion (*Allium cepa* L.) and wheat (*Triticum aestivum* L.). The testing results showed that the treatment with 0.6 mM 4,8-DHT could significantly depress the germination vigor of lettuce and wheat, reduce the germination rate of lettuce and cucumber, and also inhibit radicle length, plumule length, and fresh weight of seedlings of lettuce and onion, but could significantly promote plumule length and fresh weight of seedlings of cucumber ($p < 0.05$). For the tested five plants, the 4,8-DHT was the most active to the seed germination and seedling growth of lettuce, indicating that the phytotoxicity of 4,8-DHT had the selectivity of dosage, action target (plant type) and content (seed germination or seedling growth).

Keywords: *Carya cathayensis* Sarg.; phytotoxicity; 4,8-dihydroxy-1-tetralone; bioassay

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Received December 26, 2012
Revised March 18, 2013
Accepted March 19, 2013

Research Article

Separation and purification of flavonoid from *Taxus* remainder extracts free of taxoids using polystyrene and polyamide resin

An efficient separation process of flavonoid from *Taxus wallichiana* var. *mairei* remainder extracts free of taxoids was developed in this study. AB-8 macroporous resin and polyamide resin offered the fine adsorption capacity, and its adsorption rate at 30°C fitted well to the Langmuir and Freundich isotherms. Resin dynamic adsorption and desorption experiments were conducted to optimize the separation process of total flavonoids from *T. wallichiana* var. *mairei* remainder extracts free of taxoids. The optimum parameters for adsorption by AB-8 resin were as follows: (1) the concentration of flavonoids in a sample solution of 5.61 mg/mL with a processing volume of 2 bed volume (BV) (60 mL); (2) for desorption, ethanol–water (80:20, v/v), with 6 BV as an eluent at a flow rate of 2 BV/h. After a one-run treatment with AB-8 resin, the content of flavonoids was increased 5.10-fold from 4.05 to 20.65%. The optimum parameters for adsorption by polyamide resin were as follows: processing volume of 2 BV (30 mL); for desorption, ethanol–water (70:30, v/v), with 8 BV as an eluent at a flow rate of 2 BV/h. After one-run treatment with polyamide resin, the content of total flavonoids increased from 20.65 to 65.21%. The method will provide a potential approach for large-scale separation and purification of flavonoid for its wide pharmaceutical use.

Keywords: Flavonoids / Macroporous resins / Polyamide resin / Preparative separation / *Taxus wallichiana* var. *mairei*
DOI 10.1002/jssc.201201189

1 Introduction

Taxus was a genus of 12 species including four species in North America, one in Europe, and the remainders native to Southeast Asia [1]. Taxoids were very important compounds in many *Taxus* species, including paclitaxel, cephalomanine, 10-deacetylbaccatin III, 7-xylosyl-10-deacetyltaxol [2], and were well known for their remarkable anticancer activity. The separation of taxoids from *Taxus* was the most important discovery for human chemotherapy [3,4]. Along with the increasing need of taxoids from the genus *Taxus*, the amount of the remainder extracts free of taxoids was also increased. The content of flavonoids from *Taxus wallichiana* var. *mairei* remainder extracts free of toxoids (Treft) was about 4.05% by separation from our laboratory. These compounds had not been utilized by the industry. Therefore, it was of considerable interest to find a reasonable method for extraction, preparation of separate, and enrichment of the flavonoids from Treft.

Flavonoids, a large category of plant polyphenol secondary metabolites, were widely distributed in medicinal herbal, fruits, teas, etc. [5], and displayed a wide range of pharmacological activities, including antileukemic [6], antioxidative [7], antimutagenic [8], anti-inflammatory [9], and antiviral [10] effects as well as the ability to promote immunologic function [11]. The extraction of flavonoids from plant materials had a two-phase solvent system [12], ultrasonic-assisted extraction [13], microwave-assisted extraction [14], supercritical fluid extraction [15], and pressurized liquid extraction [16], and so forth.

Separation methods based on synthetic adsorbents were gaining popularity in pharmaceutical applications and had also been used for polyphenols separation [17]. Macroporous resin was one kind of adsorbent that was often used to separate flavonoids based on the polarity, sieve classification, hydrogen bonding interactions, and Van der Waals forces [18]. Macroporous resins had been increasingly viewed as an alternative for the separation and enrichment of effective components from many natural products [19, 20]. The adsorption by macroporous resins was the more promising separation method due to its moderate purification effect, high-adsorption capacity, low operating costs, low solvent consumption, and easy regeneration [21]; it also employed in the enrichment of many secondary metabolites, including taxoids [3], polyphenols [22], ginsenosides [23],

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Abbreviation: BV, bed volume

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Molecules **2011**, *16*, 8874-8893; doi:10.3390/molecules16108874

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ISSN 1420-3049

www.mdpi.com/journal/molecules

Article

Autotoxicity and Allelopathy of 3,4-Dihydroxyacetophenone Isolated from *Picea schrenkiana* Needles

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Received: 19 September 2011; in revised form: 9 October 2011 / Accepted: 17 October 2011 / Published: 24 October 2011

Abstract: Bioassay-guided fractionation of the diethyl ether fraction of a water extract of *Picea schrenkiana* needles led to the isolation of the phenolic compound 3,4-dihydroxy-acetophenone (DHAP). The allelopathic effects of DHAP were evaluated under laboratory conditions on *P. schrenkiana*, rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), radish (*Raphanus sativus* L.), lettuce (*Latuca sativa* L.), cucumber (*Cucumis sativus* L.) and mung bean (*Phaseolus radiatus* L.). DHAP significantly inhibited seed germination and seedling growth of *P. schrenkiana* at concentrations of 2.5 mM and 0.5 mM ($p < 0.05$). Soil analysis revealed that *P. schrenkiana* forest soils contained exceptionally high DHAP concentrations (mean = 0.51 ± 0.03 mg/g dry soil), sufficient to inhibit natural *P. schrenkiana* recruitment. DHAP also exhibited strong allelopathic potential. It significantly inhibited wheat and lettuce seed germination at concentrations of 1 mM and 0.5 mM ($p < 0.05$). The active compound also completely inhibited root growth of the six test species at high concentrations. Our results suggest a dual role of DHAP, both as an allelochemical and as an autotoxicant. The potential for a single plant needle-leached compound to influence both inter- and intra-specific interactions emphasized the complex effects that plant secondary metabolites might have on plant population and community structure.

Molecules **2010**, *15*, 8933-8952; doi:10.3390/molecules15128933

OPEN ACCESS

molecules

ISSN 1420-3049

www.mdpi.com/journal/molecules

Review

Phenolics and Plant Allelopathy

Zhao-Hui Li [1,2], Qiang Wang [1,2,*], Xiao Ruan [1,2], Cun-De Pan [3] and De-An Jiang [1,*]

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Received: 19 September 2010; in revised form: 21 November 2010 / Accepted: 25 November 2010 / Published: 7 December 2010

Abstract: Phenolic compounds arise from the shikimic and acetic acid (polyketide) metabolic pathways in plants. They are but one category of the many secondary metabolites implicated in plant allelopathy. Phenolic allelochemicals have been observed in both natural and managed ecosystems, where they cause a number of ecological and economic problems, such as declines in crop yield due to soil sickness, regeneration failure of natural forests, and replanting problems in orchards. Phenolic allelochemical structures and modes of action are diverse and may offer potential lead compounds for the development of future herbicides or pesticides. This article reviews allelopathic effects, analysis methods, and allelopathic mechanisms underlying the activity of plant phenolic compounds. Additionally, the currently debated topic in plant allelopathy of whether catechin and 8-hydroxyquinoline play an important role in *Centaurea maculata* and *Centaurea diffusa* invasion success is discussed. Overall, the main purpose of this review is to highlight the allelopacthic potential of phenolic compounds to provide us with methods to solve various ecology problems, especially in regard to the sustainable development of agriculture, forestry, nature resources and environment conservation.

Keywords: phenolic compounds; allelopathy; analysis methods; mechanisms

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NZTK20190402061

合同编号：

技术开发（委托）合同

项目名称：植提产物新功能发掘研究平台建设项目

委托方（甲方）：浙江大学宁波“五位一体”校区筹建办

受托方（乙方）：浙 江 大 学

共同受托方：浙江大学宁波理工学院

签订时间：2019，3，26

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2019 年 3 月 26 日

乙方：________________（盖章）

法定代表人/委托代理人：________________（签名）

项目负责人：________________（签名）

2019 年 4 月 3 日

《植物活性成分高效提取、制备性分离》科技创新团队合作共建协议

甲方：浙江大学宁波理工学院　　　　　　　（以下简称甲方）

乙方：宁波泰康红豆杉生物工程有限公司　　（以下简称乙方）

丙方：宁波九胜创新医药科技有限公司　　　（以下简称丙方）

丁方：　宁波天鼎生物科技有限公司　　　　（以下简称丁方）

戊方：宁波泰新生物科技有限公司　　　　　（以下简称戊方）

国家“十三五”规划纲要指出“加强中药资源保护、研究开发和合理利用，推进质量认证和标准建设，为国家十三五及今后一段时间中医药产业发展方向”。国家科技部实施的“利用现代科学技术，实施中药现代化科技产业行动，改造和重组我国传统中药产业，建立国际认可和广泛接受的现代中药研究、开发和生产体系”为国家十三五及今后一段时间中医药产业发展提供了技术路径。近年来，中药产业得到了国家高度重视，“中药现代化、产业化”被列为发展高科技产业的重要内容。国家的战略性需求是提高我国中药产品的现代科技含量和市场竞争能力，使其成为我国新的经济增长点，推动医药产业向我国支柱性产业方向发展。本团队的组织与设计完全符合国家的战略性需求和产业导向。

植物提取物是以植物为原料经过物理化学提取分离过程，定向获取和浓集植物中的某一种或多种有效成分用于医药、食品、美容以及其它行业。1994 年美国 DSHEA (Dietary Supplement Health and Education Act of 1994)公布，FDA 正式接受植物提取物作为食品补充剂使用。WHO2015 年度报告指出全球 75%的人依靠植物药作为预防和治疗手段，在世界草药、植物提取物市场总销售额 2800 亿美元中，亚洲占据 40%份额，欧洲 35%，北美洲 17%。全球植物提取物市场需求增长速度明显高于世界药品市场的增长速度，平均为 10-20%左右，其中美国为 20-30%。植物提取物作为药物、食品添加剂、保健品等的全球市场广阔，但是对植物活性成分高效提取、制备性分离技术的内在规律性认识不清和核心技术手段缺乏市场竞争力，严重制约了我市相关企业技术的进步与市场拓展。

“植物活性成分高效提取、制备性分离”创新团队以浙江大学宁波理工学院（甲方）生物与制药优势特色学科为核心，依托浙江省重点学科-化学工程与技术，整合宁波泰康红豆杉生物工程有限公司（乙方）、宁波九胜创新医药科技有限公司（丙方）、宁波天鼎生物工程有限公司（丁方）、宁波泰新生物科技有限公司（戊方）的科研条件、人力资源和市场信息为应用研究和产业化的载体。团队

针对具有重要市场前景的生物产品，从植物活性成分高效提取技术创新、植物活性成分制备性分离技术创新、植物活性成分的生物评价与验证三个研究方向出发，突破现有色谱分离理论范式，巧妙设计技术组合，创造发明系列新技术方法，为企业新产品开发提供技术支撑和知识产权保证。为了保障项目的顺利实施，全面完成项目实施任务，五方就项目申报、组织实施、成果汇总、结题验收等各项工作的开展达成以下合作协议：

一、项目研究工作分工

1、创新团队（甲方）与宁波泰康红豆杉生物工程有限公司（乙方），合作进行南方红豆杉叶中紫衫醇、紫衫黄酮、紫衫黄酮分离产品银杏素、金松双黄酮的开发。团队负责紫衫醇超声波提取工艺优化、紫杉醇模拟移动床色谱分离、紫衫黄酮超临界提取工艺优化、大规模制备色谱分离银杏素、金松双黄酮产品的小试工作和紫衫黄酮的抗氧化活性评价；企业负责几个产品的中试放大、生产过程管理，新产品市场开发。

2、创新团队（甲方）与宁波九胜创新医药科技有限公司（丙方），合作进行DHAP、4,8-DHT相关除草剂的开发。团队负责DHAP高效提取、制备性分离，4,8-DHT合成工艺优化与产物分离、DHAP、4,8-DHT实验室除草活性筛选、除草活性的田间筛选、DHAP、4,8-DHT环境降解与转化研究；企业负责几个产品的中试放大、生产过程管理，新产品市场开发。

3、创新团队（甲方）与宁波天鼎生物工程有限公司（丁方），合作进行葡萄籽提取物和红景天提取物的产品更新换代。团队负责葡萄籽超声提取工艺优化、低聚原花青素制备色谱分离、高聚原花青素生物降解工艺优化、基于超临界提取选择性提高红景天提取物中红景天苷、络塞维含量降低百脉根苷的工艺优化研究和低聚原花青素与红景天提取物抗氧化活性评价；企业负责几个产品的中试放大、生产过程管理，新产品市场开发。

4、创新团队（甲方）与宁波泰新生物科技有限公司（戊方），合作进行贝母花提取物、黄精提取物的开发。团队负责贝母花中贝母总碱的高效提取工艺研究、贝母甲素、贝母乙素制备性分离工艺的优化，贝母总碱抗炎活性评价与验证；黄精提取物中过敏性成分的模拟移动床色谱分离以及分离产物的抗氧化活性评价与筛选；企业负责几个产品的中试放大、生产过程管理，贝母花提取物新资源食品资质申请和新产品市场开发。

二、成立项目研究工作协作小组

成立团队项目研究工作协作小组，组长由项目负责人担任，成员甲、乙、丙、丁、戊方主要研究人员组成。协调项目实施进展中各种情况和问题。

三、实施项目课题负责制

团队管理实施负责人负责制，项目按专题形式展开，专题实行负责人责任制。专题负责人负责组织专题的实施，按照计划落实经费的分配，并接受项目研究工作协作小组监督。全面协调各个协作单位与承担单位的关系，督察各个单位项目实施进度，定期召开项目组研究工作会议，确保项目按期完成各项研究任务，顺利通过验收。

四、建立会议制度

团队研究工作协作小组会议每半年至少召开一次，重大问题，经项目负责人同意，随时召开。项目研究工作协作小组每半年至少检查一次示范点实施情况。课题组每半年以书面或会议形式报告一次工作进展情况，并根据项目管理要求提供相关材料。

五、经费分配办法

按照项目实施工作量及所涉及费用的大小，研究与建设经费按照以下比例分配，严格执行国家、单位有关科研经费使用管理办法，专款专用。

序号	单位名称	组织机构代码	研究任务负责人	市财政经费		归口部门经费	自筹经费	合计
				小计	其中：间接费用			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
甲方	浙江大学宁波理工学院	73016478-7	王强	300	0	0	0	300
乙方	宁波泰康红豆杉生物工程有限公司	91330201750392533B	戚军	0	0	0	200	200
丙方	宁波九胜创新医药科技有限公司	330206000015818	郑赞胜	0	0	0	200	200
丁方	宁波天鼎生物工程有限公司	91330206775603325R	钱金金	0	0	0	200	200
戊方	宁波泰新生物科技有限公司	91330205599461873P	郑波	0	0	0	50	0
累计				300	0	0	650	950

六、甲方的责任、权利、义务

1、负责团队项目前期调研并完成项目可行性报告、论证等工作；负责项目申报书的填写工作，以及材料的印刷、上报工作。

2、组织协调各个合作单位的研究工作关系，检查落实各项工作进展，通报项目研究各项工作进展。

3、负责研究材料的收集整理、汇总、汇编等工作，负责项目验收材料的准备及验收组织工作，负责与科技主管部门的沟通、汇报工作，负责组织召开项目研究工作会议。

七、乙方的责任、权利、义务

1、负责完成研究任务 1 的内容，配合其他研究任务的完成。

八、丙方的责任、权利、义务

1、负责完成研究任务 2 的内容，配合其他研究任务的完成。

九、丁方的责任、权利、义务

1、负责完成研究任务 3 的内容，配合其他研究任务的完成。

十、戊方的责任、权利、义务

1、负责完成研究任务 4 的内容，配合其他研究任务的完成。

十一、其他

项目研究成（含知识产权）归合作单位共有。本协议未尽事宜，通过研究工作协作小组协商一致解决。本协议合作期限自签订之日起至项目验收通过结束。本协议一式拾份，各单位各执贰份。

甲方：浙江大学宁波理工学院（盖章）
代表： 年 月 日

乙方：宁波泰康红豆杉生物工程有限公司 （盖章）
代表： 年 月 日

丙方：宁波九胜创新医药科技有限公司（盖章）
代表： 年 月 日

丁方：宁波天鼎生物科技有限公司 （盖章）
代表： 年 月 日

戊方：宁波泰新生物科技有限公司
代表： 年 月 日

纵向项目信息

[编辑项目信息] [返回]

⊟ 项目基本信息

归口属性	科技
项目状态	结束 [结题]
项目名称	红豆杉产业化重要科学与关键技术问题研究与应用
项目属性	纵向项目
合同号	
是否统计	是
是否对游客公开	是
是否对教育厅公开	是
项目负责人	王强
所属单位	生物与化学工程学院
所属研究所/行政单位	生物工程研究所
研究机构所在校区	
我校排名	2
项目批准（合同签订）时间	2012-01-01
申报立项时间	2012-09-24
计划结束时间	2014-12-31
项目委托单位	宁波市科技局
计划经费总额	25.00万元
已到款经费	25.00万元
项目编号	2011C11019
批准文号	
项目来源	宁波市科技局
项目类别	宁波市农业科研攻关项目
活动类型	应用研究
合作形式	与国内其他企业合作
组织形式	合作单位
学科门类	生物学
服务的国民经济行业	林业
参与项目的研究生数	
预期成果形式	新技术、新工艺
项目级别	地市级
项目层级	地市级
立项分	
结题分	
经费分	
其他研究机构	
所属实验室	
项目备注	
创建时间	2012-09-24 11:28:25

浙江大学宁波理工学院 科研处

⊟ 经费使用情况

⊟ 项目中检信息

⊟ 项目结题信息

当前状态	通过审核
创建者	adminhmr
上次修改者	adminhmr
实际结束时间	2014-12-02
申报结题时间	2014-12-02
最终成果形式	论文
申报结题材料	
最终成果存档	
最终成果说明	
项目成果	
备注	

编辑 删除 添加合同 经费 年度经费

工作量 返回

[编辑项目信息] [返回]

⊟ 项目基本信息

归口属性	科技
项目状态	进行中 [经费已到位]
项目名称	红豆杉产业化重要科学与关键技术问题研究与应用（补助）
项目属性	纵向项目
合同号	
是否统计	是
是否对游客公开	是
是否对教育厅公开	是
项目负责人	王强
所属单位	生物与化学工程学院
所属研究所/行政单位	生物工程研究所
研究机构所在校区	
我校排名	1
项目批准（合同签订）时间	2015-01-01
申报立项时间	2015-09-14
计划结束时间	2016-12-31
项目委托单位	宁波市科技局
计划经费总额	30.00万元
已到款经费	30.00万元
项目编号	
批准文号	
项目来源	宁波市科技局
项目类别	宁波市农业科研攻关项目
活动类型	应用研究
合作形式	与国内其他企业合作
组织形式	合作单位
学科门类	生物学
服务的国民经济行业	林业
参与项目的研究生数	
预期成果形式	新技术、新工艺
项目级别	资助
项目层级	地市级
立项分	
结题分	
经费分	
其他研究机构	
所属实验室	
项目备注	
创建时间	2015-09-14 14:05:22

浙江大学宁波理工学院 科研处

⊟ 经费使用情况

⊟ 项目中检信息

编辑 删除 添加合同 经费 年度经费

工作量 中检 延期 终止或撤销 申报结题

返回

纵向项目信息

[编辑项目信息] [返回]

⊟项目基本信息

归口属性	科技
项目状态	结束 [结题]
项目名称	贝母花活性成分高效制备技术集成与创新
项目属性	纵向项目
合同号	2014C10021
是否统计	是
是否对游客公开	是
是否对教育厅公开	是
项目负责人	王强
所属单位	生物与化学工程学院
所属研究所/行政单位	生物工程研究所
研究机构所在校区	
我校排名	1
项目批准（合同签订）时间	2014-07-01
申报立项时间	2014-09-29
计划结束时间	2016-07-30
项目委托单位	宁波市科技局
计划经费总额	40.00万元
已到款经费	40.00万元
项目编号	2014C10021
批准文号	鄞州、高新
项目来源	宁波市科技局
项目类别	宁波市农业科研攻关项目
活动类型	应用研究
合作形式	与国内其他企业合作
组织形式	牵头单位
学科门类	生物学
服务的国民经济行业	
参与项目的研究生数	
预期成果形式	新技术、新工艺
项目级别	地市级
项目层级	
立项分	
结题分	
经费分	
其他研究机构	
所属实验室	
项目备注	
创建时间	2014-09-29 10:17:56

浙江大学宁波理工学院 科研处

⊟经费使用情况

⊟项目中检信息

⊟项目结题信息

当前状态	通过审核
创建者	adminhmr
上次修改者	adminhmr
实际结束时间	2016-09-18
申报结题时间	2016-09-18
最终成果形式	新技术、新工艺
申报结题材料	
最终成果存档	
最终成果说明	
项目成果	
备注	

编辑 删除 添加合同 经费 年度经费 工作量 返回

证书号第1732609号

发明专利证书

发明名称：一种从南方红豆杉叶中提取杨梅素-3-O-芸香糖的方法

发　明　人：王强;阮晓

专　利　号：ZL 2012 1 0588681.9

专利申请日：2012年12月31日

专利权人：浙江大学宁波理工学院

授权公告日：2015年07月22日

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局长
申长雨

申长雨

中华人民共和国国家知识产权局
2015年07月22日

第1页（共1页）

证书号第1817527号

北京市海淀区地方税务局 印花税代扣专用章 国家知识产权局

发明专利证书

发 明 名 称：一种从南方红豆杉叶中提取山萘酚-7-O-葡萄糖的方法

发　明　人：王强;阮晓

专　利　号：ZL 2012 1 0588696.5

专利申请日：2012年12月31日

专 利 权 人：浙江大学宁波理工学院

授权公告日：2015年10月21日

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2015年10月21日

证书号第1641951号

印花税代扣专用章
北京市海淀区地方税务局
国家知识产权局

发明专利证书

发 明 名 称：一种从南方红豆杉叶中提取银杏素的方法

发 明 人：阮晓;王强

专 利 号：ZL 2012 1 0588553.4

专利申请日：2012年12月31日

专 利 权 人：浙江大学宁波理工学院

授权公告日：2015年04月22日

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2015年04月22日

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证书号第2083906号

印花税代扣专用章 国家知识产权局 北京市海淀区地方税务局

发明专利证书

发 明 名 称：从山核桃外果皮中分离纯化 4,8-DHT 的方法及 4,8-DHT 应用

发　明　人：王强

专　利　号：ZL 2014 1 0498593.9

专利申请日：2014 年 09 月 26 日

专 利 权 人：浙江大学宁波理工学院

授权公告日：2016 年 05 月 25 日

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2016 年 05 月 25 日

证书号第1969388号

发明专利证书

发 明 名 称：4,8-二羟基-1-四氢萘酮的化学合成方法

发 明 人：王强

专 利 号：ZL 2014 1 0502166.3

专利申请日：2014年09月26日

专 利 权 人：浙江大学宁波理工学院

授权公告日：2016年03月02日

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