



Article

Qualitative and Quantitative Analysis of the Major Constituents in WLJ Herbal Tea Using Multiple Chromatographic Techniques

Chao-Zhan Lin ¹ , Run-Jing Zhang ¹, Yu-Feng Yao ¹, Xiao-Dan Huang ^{2,*}, Rong-Bo Zheng ², Bo-Jian Wu ² and Chen-Chen Zhu ^{1,*}

¹ Institute of Clinical Pharmacology, Guangzhou University of Chinese Medicine, No. 12 Jichang Road, Guangzhou 510405, China; linchaozhan@gzucm.edu.cn (C.-Z.L.); zhang_runjing@sina.com (R.-J.Z.); yao_yufeng@sina.com (Y.-F.Y.)

² Research & Development Institute, Guangzhou Wanglaoji Pharmaceutical Company Limited, No. 831 Guanghuaser Road, Guangzhou 510450, China; zrbt80819@sina.com (R.-B.Z.); wu_bojian@sina.com (B.-J.W.)

* Correspondence: xiaodanhuang@126.com (X.-D.H.); zhaooc@gzucm.edu.cn (C.-C.Z.); Tel.: +86-2066830466 (X.-D.H.); +86-2036585303 (C.-C.Z.); Fax: +86-2086601051 (X.-D.H.); +86-2036588015 (C.-C.Z.)

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Abstract: Quality control of Chinese herbal tea remains a challenge due to our poor knowledge of their complex chemical profile. This study aims to investigate the chemical composition of one of the best-selling and famous brand of beverage in China, Wanglaoji Herbal Tea (WLJHT), via a full component quantitative analysis. In this paper, a total of thirty-two representative constituents were identified or tentatively characterized using ultra-high performance liquid chromatography coupled with quadrupole tandem time-of-flight mass spectrometry (UPLC-Q-TOF-MS). Moreover, the quantitative analyses of fourteen constituents were performed by high performance liquid chromatography with a triple quadrupole tandem mass spectrometry (HPLC-MS/MS) method and saccharide compositions of WLJHT were also quantitatively determined by high performance liquid chromatography (HPLC) with evaporative light scattering detector (ELSD) on a Hilsic column, separately. Using multiple chromatographic techniques presented a good precision, sensitivity, repeatability and stability, and was successfully applied to analyze 16 batches of WLJHT samples. Therefore, it would be a reliable and useful approach for the quality control of WLJHT.

Keywords: Wanglaoji herbal tea; UPLC-Q-TOF-MS; HPLC-MS/MS; evaporative light scattering detector

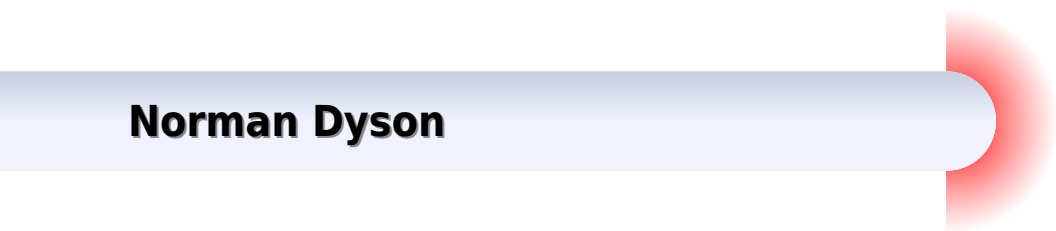
1. Introduction

Traditional Chinese herbal tea, developed by Chinese people during the long-term for disease prevention and health care under the guidance of traditional Chinese medicine, has been approved as an intangible cultural heritage by the Chinese government in 2006 [1–3].

Wanglaoji Herbal Tea (WLJHT), founded in the Daoguang eighth year of Qing Dynasty (Ad 1828), is the earliest Cantonese herbal tea and recognized as the ancestor of herbal tea. It is consisted of seven traditional Chinese medicines (*Chinese Mesona*, *Plumeriaeflos*, *Loniceraejaponicaeflos*, *Chrysanthemiflos*, *Prinosellae Spica*, *Microctis Folium* and *Glycyrrhizae Radix et Rhizoma*), and widely used for heat-clearing, detoxicating, engender liquid and allay thirst. Modern pharmacological studies have proven its protective effects on liver damage [2], improvement of cytotoxic T Lymphocytes activity in spleen [4], amelioration on lipids metabolism [5] and glucometabolism [6], and enhancement of immune functions of restrain-stress mice [7]. In our previous phytochemical study [8], several polyphenol constituents as phenolic acids and flavonoids were separated and structural elucidated from WLJHT.

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Techniques and Practice of Chromatography Raymond P.W. Scott, 2020-01-29 This work introduces scientists of all disciplines to the chromatographic process and how it functions The basic principles of chromatographic separation and specific chromatographic procedures including gas liquid and thin layer chromatography are covered For each separation method the book details its characteristics the instrumentation required the procedures necessary for effective use areas of application and examples of its use This work is intended for analytical chemists laboratory technicians and upper level undergraduate and graduate students in analytical chemistry or separation science courses

Chromatographic Techniques Mr. Rohit Manglik, 2024-04-08 Separation methods are covered Guides students to analyze chromatographic processes fostering expertise in analytical chemistry through laboratory experiments and theoretical study

Principles and Practice of Modern Chromatographic Methods Kevin Robards, Danielle Ryan, 2021-12-03 Principles and Practice of Modern Chromatographic Methods Second Edition takes a comprehensive unified approach in its presentation of chromatographic techniques Like the first edition the book provides a scientifically rigid but easy to follow presentation of chromatography concepts that begins with the purpose and intent of chromatographic theory the what and why that are left out of other books attempting to cover these principles This fully revised second edition brings the content up to date covering recent developments in several new sections and an additional chapter on composite methods New topics include sample profiling sample preparation sustainable green chemistry 2D chromatography miniaturization nano LC HILIC and more Contains thorough chapters that begin with an updated schematic overview and a visual representation of the content Avoids the obfuscation of different terminologies and classification systems that are

prevalent in the area such as the relationship between liquid chromatography and column chromatography Provides integrated and comprehensive topic coverage based on chromatographic bibliometrics and survey reports on the relative usage of chromatographic techniques **Advances in Chromatographic Techniques for Therapeutic Drug Monitoring** Amitava Dasgupta,2009-10-06 For drugs with a narrow therapeutic index therapeutic drug monitoring methods are essential for patient management Although immunoassays are commercially available for many drugs and most laboratories use these assays for routine therapeutic monitoring they have many limitations which hinder their efficacy Providing practical guidelines for imp **Chromatographic Integration Methods** Norman Dyson,2007-10-31 The second edition of the popular Chromatographic Integration Methods has been completely revised and updated Written by an expert with many years experience with two of the world s largest manufacturers of computing integrators it has been expanded to include a new section on validation of integrators in response to regulatory requirements for quality and validation A new literature survey additional diagrams and Author Index have also been added Well illustrated and easily read this is an excellent source book for those who wish to increase their understanding of integrators Chromatographic Integration Methods describes and discusses both manual and electronic techniques used with the aim of aiding analysts to obtain more data from their chromatograms and assist them with understanding how integrators work so that results are never accepted unquestioningly As with the first edition this book will be welcomed by all those in the chromatography field particularly those at the bench

Plant Analysis: Comprehensive Methods and Protocols B.K. Garg,2012-06-01 The book Plant Analysis Comprehensive Methods and Protocols is a complete laboratory manual for analytical methods and techniques in the field of Agriculture Plant Physiology Biochemistry and related Plant Sciences Right from nutrient analysis in plants it covers estimations of macromolecules such as amino acids proteins nucleic acids and metabolites of fatty acid metabolism Protocols for the assay of various enzymes of nitrogen metabolism ammonia assimilation photosynthetic CO₂ fixation reactive oxygen species carbohydrate phosphorus and energy metabolism have been elucidated in the book Special emphasis has also been given to techniques on specific topics such as Electrophoresis Molecular Biology Histo enzymology Symbiotic Nitrogen Fixation and assay of plant growth hormones Thus the present book is one stop solution for all important techniques and analytical methods for students and research workers engaged in plant sciences and agricultural research Practical High-Performance Liquid Chromatography Veronika R. Meyer,2013-03-25 Jump into the HPLC adventure Three decades on from publication of the 1st German edition of Veronika Meyer s book on HPLC this classic text remains one of the few titles available on general HPLC aimed at practitioners New sections on the following topics have been included in this fifth edition Comparison of HPLC with capillary electrophoresis How to obtain peak capacity van Deemter curves and other coherences Hydrophilic interaction chromatography Method transfer Comprehensive two dimensional HPLC Fast separations at 1000 bar HPLC with superheated water In addition two chapters on the instrument test and troubleshooting in the appendix have

been updated and expanded by Bruno E Lendi and many details have been improved and numerous references added A completely new chapter is presented on quality assurance covering Is it worth the effort Verification with a second method Method validation Standard operating procedures Measurement uncertainty Qualifications instrument test and system suitability test The quest for quality Reviews of earlier editions That this text is written by an expert in both the practice and teaching of HPLC is evident from the first paragraph not only an enjoyable fascinating and easy read but a truly excellent text that has and will serve many teachers students and practitioners very well The Analyst provides essential information on HPLC for LC practitioners in academia industry government and research laboratories a valuable introduction American Journal of Therapeutics

Value Added Products From Bioalgae Based Biorefineries: Opportunities and Challenges

Shailendra Kumar Arya, Madhu Khatri, Gursharan Singh, 2024-05-27 This book covers wide aspects of algal technology and algae based biorefinery aspects Algae are the most prevalent primitive and abundant microbes on Earth however the commercialization of algal based value added products is still low due to the negligible dissemination of knowledge flow among the stakeholders and researchers This book provides up to date information on the cultivation of microalgae their harvesting downstream processing and diverse applications It further discusses the macromolecules existing in microalgae such as proteins carbohydrates and lipids poly unsaturated fatty acids peptides exo polysaccharides flavonoids and antioxidants This book also highlights the advantages and some real time challenges before the establishment of sustainable algal based biorefineries Further it includes clear flow charts and figures in each chapter to aid in interpretation of every technical concept This book motivates readers entrepreneurs and young farmers to exploit easily growing microalgae through cottage to large scale biorefineries and start their own businesses for the production of value added products

Chromatography, 2011-08-26 Chromatography *Cumulated Index Medicus*, 1970 Thin Layer Chromatography in Phytochemistry Monika Waksmundzka-Hajnos, Joseph Sherma, Teresa Kowalska, 2008-03-04 Thin layer chromatography TLC is increasingly used in the fields of plant chemistry biochemistry and molecular biology Advantages such as speed versatility and low cost make it one of the leading techniques used for locating and analyzing bioactive components in plants Thin Layer Chromatography in Phytochemistry is the first source

Encyclopedia of Chromatography Jack Cazes, 2009-10-12

Thoroughly revised and expanded this third edition offers illustrative tables and figures to clarify technical points in the articles and provides a valuable reader friendly reference for all those who employ chromatographic methods for analysis of complex mixtures of substances An authoritative source of information this introductory guide to specific chromatographic techniques and theory discusses the relevant science and technology offering key references for analyzing specific chemicals and applications in industry and focusing on emerging technologies and uses *TRAC: Trends in Analytical Chemistry* U A Th Brinkman, J. G. Dorsey, J R Durig, 2013-09-24 TRAC Trends in Analytical Chemistry Volume 7 provides information pertinent to the trends in the field of analytical chemistry This book discusses a variety of topics related to analytical

chemistry including biomolecular mass spectroscopy affinity chromatography electrochemical detection nucleosides and protein sequencing Organized into 63 parts encompassing 158 chapters this volume begins with an overview of the significance of quality and productivity in the analytical laboratory This text then presents a comprehensive review on alcohol dehydrogenases immobilization and applications in analysis and synthesis Other chapters consider the various tests for determining the excellence of quantitative assays available for analysts to utilize for method validation This book discusses as well the primary challenge of neuropharmacologists to relate physiological functions to the many ligand binding sites identified in brain tissue The final chapter deals with the fundamentals and applications of biosensors This book is a valuable resource for analytical chemists chemical engineers clinical chemists neuropharmacologists and scientists *Handbook of Thin-Layer Chromatography* Joseph Sherma, Bernard Fried, 2003-04-18 In this third edition more than 40 renowned authorities introduce and update chapters on the theory fundamentals techniques and instrumentation of thin layer chromatography TLC and high performance thin layer chromatography HPTLC highlighting the latest procedures and applications of TLC to 19 important compound classes and coverage of TLC applications by compound type Easily adaptable to industrial scenarios the Handbook of Thin Layer Chromatography Third Edition supports practical research strategies with extensive tables of data offers numerous figures that illustrate techniques and chromatograms and includes a glossary as well as a directory of equipment suppliers **Chromatography Today** C.F. Poole, S.K. Poole, 2012-12-02 Chromatography Today provides a comprehensive coverage of various separation methods gas liquid thin layer and supercritical fluid chromatography and capillary electrophoresis Particular attention is paid to the optimization of these techniques in terms of kinetic parameters and retention mechanisms When these facts are understood method selection and optimization becomes a more logical process Sample preparation methods are treated fully as they frequently represent an integral part of the total analytical method Also described are preparative scale separations used for isolating significant amounts of product which are generally achieved under conditions that are not identical to those used for analytical separations The most common hyphenated methods used for sample identification are discussed from the perspective of the information they yield and the requirements of common interfaces The scope and level of discussion are designed to be appropriate for various user groups This book should be suitable for use as a graduate level student textbook in separation science a text for professional institutes offering short courses in chromatography and as a self study guide for chromatographers to refresh their knowledge of the latest developments in the field The book is extensively illustrated with over 200 figures 110 tables and 3 300 references largely to the contemporary literature **Handbook of Plant Ecophysiology Techniques** M. J. Reigosa Roger, 2007-05-08 The Handbook of Plant Ecophysiology Techniques you have now in your hands is the result of several combined events and efforts The birth of this handbook can be traced as far as 1997 when our Plant Ecophysiology lab at the University of Vigo hosted a practical course on Plant Ecophysiology Techniques That course showed us how much useful a

handbook presenting a bunch of techniques would be for the scientists beginning to work on Plant Ecophysiology In fact we wrote a short handbook explaining the basics of the techniques taught in that 1997 course Flow cytometry to measure ploidy levels Use of a Steady State porometer to measure transpiration In vivo measure of fluorescence HPLC analysis of low molecular weight phenolics Spectrophotometric determinations of free proline and soluble proteins TLC polyamines contents measures Isoenzymatic electrophoresis Use of IRGA and oxygen electrode That modest handbook written in Spanish was very helpful both for the people who attended the course and for other who have used it for beginning to work in Plant Ecophysiology The present Handbook is much more ambitious and it includes more techniques But we have also had in mind the young scientists beginning to work on Plant Ecophysiology In 1999 Fran ois Pellissier leaded a proposal presented to the European Commission in the Fifth Framework Program in the High Level Scientific Conferences including three EuroLab Courses about lab and field techniques useful to improve allelopathic research

Handbook Of Size Exclusion Chromatography And Related Techniques Chi-San Wu, 2003-11-04 Documenting critical advances in this rapidly evolving field the Second Edition highlights the need for new applications and technologies that assist in the determination of molecular weight and molecular weight distributions of polymers in an accurate efficient manner This volume presents the latest findings from a international team of specialists and continues to inspire and extend practical applications of size exclusion chromatography SEC It includes six new chapters covering high speed size exclusion chromatography SEC of low molecular weight materials and the extended family of techniques from two dimensional liquid chromatography to high osmotic pressure chromatography

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