Authentication of *Zingiber officinale* samples as Raw Material and In Herbal Formulations by Multivariate Analysis

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Abstract

Ginger rhizome (*Zingiber officinale* Roscoe) is a widely used medicinal plant and spice since antiquity. It has many biological activities and is commonly used as a home remedy herbal tea. Hence, it's usually subjected to adulteration. Besides, clinical investigations involved the study of ginger's biological activity showed mixed and variable results. This may be due to the lack of appropiate method of standardization. Thus, an adequate method is required for its quality control. This study investigated the use of different spectroscopic techniques for complete fingerprint analysis of ginger with further chemometric analysis as a successful model for the discrimination of different ginger samples according to their geographical origin. . In addition, a stability study is performed on stored ginger for the detection of storage effect on the stability of its main active constituents. The study involved the use of 22 authentic ginger samples obtained from different geographical origins and 39 samples obtained from different regions of the Egyptian market. Results showed that UV spectroscopy and HPLC analysis coupled with chemometrics can be used successfully for discrimination of ginger according to its geographical origin. Also, storage of ginger greatly affect its stability and concentration of its pungent principles decrease remarkably especially when stored in powder form.

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List of Abbreviations

GRAS	Generally Recognized As Safe
FDA	Food and Drug Administration
GAE	Gallic Acid Equivalents
GSH	Glutathione
MMP-2/-9	Matrix Metalloproteinase
uPA	Urokinase-type Plasminogen Activator
TBX2	Thromboxane-B2
PGE2	Prostaglandin-E2
MIC	Minimum Inhibitory Concentration
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs
GLUT4	Glucose Transporter type 4
PLA2	Phospholipase A2
IGR	Insect growth regulatory
HPLC	High Performance Liquid Chromatography
HPTLC	High Performance Thin Layer Chromatography
TLC	Thin Layer Chromatography
GC	Gas Chromatography
UV	Ultraviolet
RP-HPTLC	Reverse phase-High Performance Thin Layer Chromatography
HPLC-NMR	High Performance Liquid Chromatography-Nuclear Magnetic Resonance Spectroscopy
NMR	Nuclear Magnetic Resonance
HPLC-DAD	High Performance Liquid Chromatography-Diode Array Detector
MS	Mass Spectrometry
ECD	Electrochemical Array Detector
TOF	Time-Of-Flight Mass Spectrometry

List of Abbreviations (Cont.)

LC-TOF/MS	Liquid Chromatography -Time-Of-Flight Mass Spectrometry
FD	Flavor Dilution Factor
SPME	Solid Phase Micro-Extraction
MD-SPME	Microwave Distillation and Solid Phase Micro-Extraction
SDE	Steam Distillation Extraction
PEE	Petrol Ether Extraction
HS-SPME	Head Space Solid Phase Micro-Extraction
GC-FID	Gas Chromatography-Flame Ionization Detector
GC-MS	Gas Chromatography-Mass Spectrometry
PCR	Polymerase Chain Reaction
SCAR	Sequence-Characterized Amplified Region
RAPD	Random Amplification of polymorphic DNA
LAMP	Loop-Mediated isothermal Amplification
SFDA	State Food and Drug Administration of China
IR	Infrared
WFA	Window Factor Analysis
EFA	Evolving Factor Analysis
HELP	Heuristic Evolving Latent Projections
CLC	Capillary Liquid Chromatography
DA	Discriminant Analysis
HPLC-PDA	High Performance Liquid Chromatography-Photodiode Array Detector
HCA	Hierarchical Cluster Analysis
PCA	Principal Component Analysis
LDA	Linear Discriminant Analysis
UPLC	Ultra Performance Liquid Chromatography

List of Abbreviations (Cont.)

UPLC-Q/TOF-MS	Ultra Performance Liquid Chromatography-Quadrupole / Time Of Flight Mass Spectrometry
SIMCA	Soft Independent Modelling by Class Analogy
OPLS	Orthogonal Partial Least Square regression
2D GC	Two Dimensional Gas Chromatography
2D GC-MS	Two Dimensional Gas Chromatography-Mass Spectrometry
FT-IR	Fourier Transform Infrared
TMS	Tetramethylsilane
DMSO	Dimethyl sulfoxide
ELSD	Evaporative Light Scattering Detector
ELPG	Evolving Latent Projection Graph
AST	Aspartate Aminotransferase
ALT	Alanine Transaminase
ALP	Alkaline Phosphatase

Introduction

Literature Review

Taxonomy, Biology, Chemistry and Quality control of ginger

Materials, Methods and Apparatus

Results and Discussion