

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 appropriate 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.

Table of content

	Page
Acknowledgment	i
Abstract	ii
Table of Content	iii
List of Figures	v
List of Tables	vii
List of Abbreviations	viii
 Introduction	 1
Literature Review	3
Taxonomy of Ginger Rhizome	3
Botanical Characters of Ginger Rhizome	3
- Macroscopical characters.....	4
- Microscopical characters	4
- Origin of cultivation.....	5
- Ginger Rhizome (<i>Zingiber officinale</i> Roscoe)varieties	6
- Ginger in the market	6
Review of Ginger Chemistry	8
Review of Ginger Biology	14
Quality control of Ginger.....	20
 Statement of the Problem	 40
Work Strategy	41
Materials, Methods and Apparatus	43
1. Sample Collection and Preparation.....	43
2. Solvents and Standards	46
3. Apparatus	46

Table of Content (Cont.)

4. Software	47
5. Methods and Procedure.....	47

Results and Discussion

Chapter I:

Different spectroscopic methods coupled with chemometrics for effective discrimination of ginger according to its geographical origin50

1. UV spectroscopy as a chemometric model for discrimination of ginger samples according to its geographical origin and other quality affecting factors	50
2. FT-IR spectroscopy as a chemometric model for classification of ginger samples according to its geographical origin.....	59
3. NMR spectroscopy as a chemometric model for discrimination of ginger samples according to its geographical origin.....	63

Chapter II:

Chromatographic techniques coupled with chemometrics for effective classification and authentication of ginger samples according to its geographical origin66

1. HPLC as a chemometric model for authentication of ginger samples.....	66
1.1. Standardization of the HPLC method for analysis of ginger.....	66
1.2. HPLC results for the authentic samples.....	69

Chapter III:

Stability study to detect the effect of storage on the quality of ginger samples and concentration of its main pungent principles75

1. Stability study using HPLC-UV coupled with chemometrics	75
2. Effect of storage on the concentrations of the pungent principles of ginger authentic samples	77

Summary.....	80
---------------------	-----------

References	85
-------------------------	-----------

Arabic summary

List of Figures

Figure	Page
1. Chemical structures of common pungent phytochemicals in ginger.....	13
2. UV absorption spectrum of authentic ginger sample C1.....	54
3. UV absorption spectrum of authentic Indian ginger sample I1	54
4. UV absorption spectrum of authentic Nigerian ginger sample N1	54
5. PCA score plot of UV spectral data (200-800nm) for authentic samples	56
6. PCA score plot of UV spectral data (200-400nm) for authentic samples	57
7. PCA score for UV results of maximum wavelengths (230,280) of authentic ginger samples (average of three replicates)	57
8. HCA dendrogram of UV spectral data (200-800nm) for authentic ginger samples	58
9. PCA score of UV spectral data (200-400nm) for Egyptian market and authentic ginger samples	59
10. SIMCA plot for challenging of Egyptian marketed samples with PCA models	60
11. FT-IR chart for Chinese sample (C1).....	62
12. FT-IR chart for Indian sample (I1).....	62
13. FT-IR chart for Nigerian sample (N1).....	62
14. PCA score plot for FT-IR raw data matrix (4000-400 cm ⁻¹) of authentic ginger samples (average of three replicates)	63
15. HCA dendrogram for FT-IR raw data matrix (4000-400 cm ⁻¹) of authentic ginger samples	64
16. ¹ H-NMR spectra (0-15 ppm) for authentic ginger samples.....	65
17. PCA score plot of ¹ H NMR spectra region (0-15 ppm) for authentic ginger samples	66
18. Calibration curve for 6-gingerol with R ² value	69
19. Calibration curve for 8-gingerol with R ² value	69
20. Calibration curve for 10-gingerol with R ² value	70
21. Calibration curve for 6-shogaol with R ² value	70
22. HPLC fingerprint profile for sample C1	72

List of Figures (Cont.)

23. HPLC fingerprint profile for sample S1	72
24. HPLC fingerprint profile for sample I1	72
25. PCA score plot for HPLC results of the authentic ginger samples	73
26. PCA score plot for HPLC results of average HPLC run of authentic ginger samples (average of three replicates)	74
27. PCA score plot for HPLC results of peak areas of standards of authentic ginger samples	75
28. HCA score plot for HPLC results of average HPLC run of authentic samples	75
29. PCA score plot for HPLC results of authentic samples before and after storage	78
30. HCA score plot for HPLC results of the authentic samples after storage	78
31. Some of the authentic ginger samples obtained from different geographical origins	47
32. Examples of the obtained Egyptian market samples	48
33. Concentration Column charts of the four pungent principles of ginger before and after storage	82

List of Tables

Table	Page
1. Application of different chromatographic techniques for the quality control of ginger	34
2. Application of DNA-based marker for the quality control of ginger	37
3. Quality control of ginger using chromatographic techniques coupled with chemometrics	38
4. Imported authentic samples, their codes, geographical origins and weight in grams	43
5. Collected Egyptian market samples used during the course of study, codes, source and weight in grams	44
6. Concentrations of four pungent principles (6, 8, 10-gingerol and 6-shogaol) before and after storage	78

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-	Ultra Performance Liquid Chromatography-
Q/TOF-MS	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