



Faculty of Science
Botany Department

Morphological and Phytochemical Studies on Some Medicinal Plants in Bani Matar District (Yemen)

**A Thesis Submitted for the Degree of Doctor of Philosophy of
Science in Botany (Taxonomy of Flowering Plants)**

By

Anhar Abdulkarim Yany

B. Sc (Biology, 2002)

M.Sc. in Botany, Faculty of Science, Sana'a University, Yemen (2009)

Supervisors

Soad Abd Allah Hassan

Professor of Taxonomy of Flowering Plants
Botany Department, Faculty of Science, Ain Shams University

Zeinab Abd EL-Samie Elwan

Associate Professor of Taxonomy of Flowering Plants
Botany Department, Faculty of Science, Ain Shams University

Omayma Abd AL-Karim Eldahshan

Associate Professor of Pharmacognosy
Acting Head of Pharmacognosy Department,
Faculty of Pharmacy, Ain Shams University

Hassan Mohammed Ibrahim

Assistant Professor of Plant Taxonomy and Flora,
Biology Department, Faculty of Science, Sana'a University

**Botany Department
Faculty of Science
Ain Shams University
2018**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿فَبَدَّلْنَا بِالْعَرَاءِ وَهُوَ سَقِيمٌ * وَأَنْبَتْنَا عَلَيْهِ شَجَرَةً مِّنْ يَقْطِينٍ﴾

الصافات: ١٤٥-١٤٦

﴿وَالْأَرْضَ وَضَعَهَا لِلْأَنَامِ * فِيهَا فَاكِهَةٌ وَالنَّخْلُ ذَاتُ الْأَكْمَامِ
* وَالْحَبُّ ذُو الْعَصْفِ وَالرَّيْحَانُ﴾

الرحمن: ١٠-١٢

صِرَافُ اللَّهِ الْعَظِيمِ



Faculty of Science
Botany Department

APPROVAL SHEET

Title: Morphological and Phytochemical Studies on Some Medicinal Plants in
Bani Matar District (Yemen).

Degree: Doctor of Philosophy of Science in Botany (Taxonomy of Flowering Plants).

Name of Student: Anhar Abdulkarim Yany

Supervision Committee

Prof . Dr. Soad Abd Allah Hassan: Professor Of Taxonomy of Flowering Plants, Botany Department, Faculty of Science, Ain Shams University

Dr. Zeinab Abd EL-Samie Elwan: Associate Professor of Taxonomy of Flowering Plants, Botany Department, Faculty of Science, Ain Shams University

Dr. Omayma Abd AL-Karim Eldahshan: Associate Professor Of Pharmacognosy, Acting Head of Pharmacognosy Department, Faculty of Pharmacy, Ain Shams University

Dr. Hassan Mohammed Ibrahim: Assistant Professor of Plant Taxonomy and Flora, Biology Department, Faculty of Science, Sana'a University

Examination Committee

Prof. Dr. Majid Mahmood Abou El enin : Professor Of Taxonomy of Flowering Plants and Flora, Biology and Geology Department , Dean of Faculty of Education, Ain Shams University.

Prof. Dr. Magda Tohamy Ibrahim Salama : Professor Of Pharmacognosy Acting Head of Pharmacognosy Department, Faculty of Pharmacy, Al-Azhar University.

Prof . Dr. Soad Abd Allah Hassan: Professor Of Taxonomy of Flowering Plants, Botany Department, Faculty of Science, Ain Shams University.

Dr. Omayma Abd AL-karim Eldahshan: Associate Professor Of Pharmacognosy, Acting Head of Pharmacognosy Department, Faculty of Pharmacy, Ain Shams University

Prof. Dr. Magda Mahmoud Elaraby
Head of Botany Department

Date
/ /2018

Declaration

This thesis has not been previously submitted for a degree at this or any other university.

Anhar Abdulkarim Yany



Dedication

*This Endeavors Is Dedicated
To My Beloved Father, Mother
And All My Family For Their Love
Support And encouraging during all my
life, thanks for being here for me.*

Anhar Abdulkarim Yany

4/ 9/2018

Acknowledgement

All praises are due to **Allah SWT** who had given me blessing, strength, knowledge and save me in finishing this thesis. Salawat and salam also propose to the Prophet **Mohammed SAW**.

I would like to take this opportunity to convey my cordial gratitude and appreciation to my worthy, reverently and zealot supervisor **Prof. Dr. Soad Abd Allah Hassan, Dr. Zeinab Abd EL-Samie ELwan**, Taxonomy of Flowering Plants, Botany Department, Faculty of Science, Ain Shams University **Dr. Omayma Abd AL-Karim Eldahshan**, Pharmacognosy Department, Faculty of Pharmacy, Ain Shams University and **Dr. Hassan Mohammed Ibrahim** Plant Taxonomy and flora, Biology Department, Faculty of Science, Sana'a University, for their kind supervision, advice and sincere efforts throughout this work. Without whose constant help, deep interest and vigilant guidance, the completion of this thesis was not possible. I am really indebted to him for his accommodative attitude, thought provoking guidance, immense intellectual input, patience and sympathetic behavior. I would like to express my thanks and gratitude to the local community, who did not hesitate to give me information and help me in collecting the materials. My sincere thanks and appreciation and gratitude to my **father** and my **brother Nasr**, who accompanied me to collect informations and samples from the study area despite the circumstances of the war in Yemen. My gratitude is extended to my friends **Ebtesam Alhamizi** who helped me during oils isolation in Yemen. To all those who have contributed to the completion of this thesis and whose names do not appear here, I would like to express my sincere gratitude. Sincere thanks are also offered to all staff members of Botany Department, Faculty of Science and Faculty of Pharmacy, Ain Shams University.



ABSTRACT

Abstract

Morphological and phytochemical studies on some medicinal plants in Bani Matar District - Yemen

Anhar A. Yany¹

¹Botany Department, Faculty of Science, Ain Shams University, Cairo, Egypt.

The medicinal plants in Bani Matar District (Sana'a - Yemen) have never been phytochemically or biologically investigated. These plants have great importance due to its extensive use in folk medicine and for the commercial production of essential oils especially the species of the family Lamiaceae. So, this study was carried out on 16 selected medicinal taxa from family Lamiaceae from Bani Matar District. The collected samples were identified and investigated morphologically (whole plant), anatomically (stem, petiole and leaf) by LM., phytochemically and biologically. Also, ethnomedicinal study was carried out to document the knowledge about these plants. Finally, the recorded macro-and micromorphological data with phytochemical essential oils components were analysed using the software *jmp* version 13 and resulted in two dendrograms. The evaluation of macro- and micromorphological characters revealed that many characters *viz.* leaf composition, stomatal types and distributions number of stamens, stem vascular cylinder, petiole outline and vasculature types of trichomes, nutlet features, the number of palisade to spongy layers and crystals, are valuable in species identification and delimitation.

Also, the results revealed a relation between types of trichomes and the amount of essential oils produced. Our leaf anatomical results were useful in inferring the interspecific relationships along with the phytochemical results. Documentation to the indigenous knowledge (from the tribal of the study area) were carried out through the ethnobiological approach. It is important for species conservation and sustainable resource use. This study may could be a starting point to the discover more crude drugs of economic importance

especially from that are not documented yet before; (*Lavandula citriodora*, *Meriandra dianthera* and *Salvia schimperi*). Also, this study obviously confirmed that, the leaves are the most common part used in traditional treatments.

Fourteen Lamiaceae species were also investigated phytochemically by gas chromatography coupled with mass spectrometer. The antimicrobial activity of oils was assessed using agar-well diffusion method toward representatives for each of Gram- negative & positive bacteria in addition to fungi. One hundred and forty one compounds were identified from the studied taxa. The antimicrobial activity could be attributed to the presence of major components as carvacrol (54%, 52%), α -pinene (56%, 34%, 34%), Z-caryophyllene (16%, 10%), caryophyllene oxide (20%) and camphor (64%) and the synergistic effect with other compounds in the oil. The strongest antimicrobial activity against most pathogenic microbial tested was observed in *Lavandula pubescens*, *Thymus serpyllum*, *Teucrium yemense*, *Stachys yemenensis*, *Otostegia fruticosa*, *Ocimum basilicum* var. *basilicum* and *Salvia schimperi*.

The present study indicated that, *Salvia schimperi* can be used as a natural antibiotic (for superficial infections of the skin, oral and vaginal candidiasis caused by *candida albicans* also as natural antidiabetic .

So, from this results we can conclude that there are variations in chemical composition between tested plants that affected their antimicrobial activity and so could be used for selection of potential oil which act as a natural antibiotic. More studies on much taxa still needed about this district.

Key words: Antimicrobial activity, Lamiaceae, morphological, phyto-chemical, volatile oil, Yemen.

Contents

Title	Page
Approval Sheet	I
Declaration	ii
Dedication	iii
Acknowledgement	iv
Abstract	V
Contents	viii
List of tables	ix
List of figures	xii
List of plates	xiii
List of maps	xiv
List of abbreviations	xv
Preface	1
The aim of the study	4
Chapter one	
I. Introduction	
A. Systematic position of Lamiaceae	5
B. Taxonomic history of Lamiaceae	6
C. Study area	12
II. Literature review	
A. Macromorphological study	19
B. Micromorphology study	19
C. Ethnomedicinal study	24
D. Biological study	27
Chapter two	
I. Materials	31
II. Methods	34

Contents

Chapter three	Page
Observations of macro- and micromorphology	46
Chapter four	
Results and Discussion	
I. Macro- and micromorphological characters	126
II. Ethnomedicine of Lamiaceae in Bani Matar (Yemen)	178
III. Phytochemical and biological studies	183
IV. Cluster analysis	
A. Cluster analysis of macro – and micromorphology	244
B. Cluster analysis of chemical components of essential oils	250
Summary	254
References	262
Appendix	
Appendix I. Data matrix of 298 attributes macro-and micromorphological of the 16 medicinal studied taxa of Lamiaceae.	286
Appendix II. Data matrix of 141 attributes essential oil composition of the 16 medicinal studied taxa of Lamiaceae.	299
Appendix III. View from Jabal al-Nabī Shu‘ayb (3355 m)	304
الملخص العربي	١
التوصيات	١١

List of tables

Table	Title	Page
1	Placement of Lamiaceae according to DE Dalla & Harms, Bentham & Hooker, Thorn & Reveal, Takhtajan and APG IV.	5
2	Bentham & Hooker (1673 -1876) classification.	6
3	Briquet (1895 - 1897) classification.	7
4	Thonner (1962) classification.	8
5	Taxonomic position of the studied genera according to Cantino <i>et al.</i> (1992 c).	10
6	Taxonomic position of the studied genera according to Takhtajan, (2009).	11
7	The rainfall average (ml) and temperature in Yemen	18
8	Pharmacological activities of some selected taxa of Lamiaceae essential oils.	28
9	Antibacterial activity of some selected taxa of Lamiaceae essential oil against several microorganisms.	30
10	The list of 16 studied medicinal taxa of Lamiaceae and their data of collection	32
11	Questionnaire to collect data on medicinal plants used in the district of Bani Matar	37
12	Qualitative morphological characters of the 16 medicinal studied taxa of Lamiaceae.	135
13	Leaf general morphology of the 16 medicinal studied taxa of Lamiaceae.	136
14	Flower and nutlet morphology of the 16 medicinal studied taxa of Lamiaceae	137

15	Stem micromorphological characters of the 16 medicinal studied taxa of Lamiaceae.	147
----	---	-----

Table	Title	Page
16	Petiole micromorphological characters of seven medicinal studied taxa of Lamiaceae (nine taxa sessile).	153
17	Lamina micromorphological characters of the 16 medicinal studied taxa of Lamiaceae.	158
18	Lamina epidermal characteristics of the 16 medicinal studied taxa of Lamiaceae.	162
19	Types of eglandular and glandular trichomes of the 16 medicinal studied taxa of Lamiaceae.	168
20	Quantitative macromorphological measurements of 16 studied medicinal taxa of Lamiaceae	175
21	Quantitative micromorphological measurements of 16 studied medicinal taxa of Lamiaceae.	176
22	Sixteen medicinal plants used by local community of Bani Matar district (Yemen).	180
23	Results of the phytochemical analysis of the 14 medicinal studied taxa of Lamiaceae.	184
24	Physical characters of the essential oils of the 14 medicinal studied taxa of Lamiaceae.	185
25	Essential oil composition of <i>Lavandula pubescens</i> .	187
26	Essential oil composition of <i>Leucas inflata</i> .	189
27	Essential oil composition of <i>Marrubium vulgare</i> .	191
28	Essential oil composition of <i>Menthe longifolia</i>	193
29	Essential oil composition of <i>Meriandra dianthera</i>	195
30	Essential oil composition of <i>Nepeta deflersiana</i> .	197
31	Essential oil composition of <i>Ocimum basilicum</i> var. <i>basilicum</i> .	199
32	Essential oil composition of <i>Ocimum basilicum</i> var. <i>purpurascens</i> .	201
33	Essential oil composition of <i>Origanum majorana</i> .	203
34	Essential oil composition of <i>Otostegia fruticosa</i> .	205
35	Essential oil composition of <i>Salvia schimperii</i> .	207

36	Essential oil composition of <i>Stachys yemenensis</i> .	209
37	Essential oil composition of <i>Teucrium yemense</i> .	211
38	Essential oil composition of <i>Thymus serpyllum</i> .	213
Table	Title	Page
39	Essential oil composition of the 14 medicinal studied taxa of Lamiaceae in Yemen.	217
40	Antimicrobial activity of the selected Lamiaceae medicinal plants volatile oils expressed as inhibition zone diameter [mm].	233
41	Antimicrobial activity as MIC ($\mu\text{L/mL}$) of the selected Lamiaceae medicinal plants volatile oils	234
42	Anti-dibetic activity of the four selected Lamiaceae taxa	235
43	The proposed treatment based on cluster analysis of the 16 medicinal studied taxa of Lamiaceae.	248
44	The proposed treatment based on cluster analysis of the 14 medicinal studied taxa of Lamiaceae.	252

List of figures

Fig.	Title	Page
1	Percentage of used plant parts.	179
2	Percentage of utilized Lamiaceae medicinal taxa in Bani Matar.	179
3	Total ion chromatogram of <i>Lavandula pubescens</i> essential oil.	186
4	Total ion chromatogram of <i>Leucas inflata</i> essential oil.	188
5	Total ion chromatogram of <i>Marrubium vulgar</i> essential oil.	190
6	Total ion chromatogram of <i>Menthe longifolia</i> essential oil	192
7	Total ion chromatogram of <i>Meriandra dianthera</i> essential oil	194
8	Total ion chromatogram of <i>Nepeta deflersiana</i> essential oil.	196
9	Total ion chromatogram of <i>Ocimum basilicum</i> var. <i>basilicum</i> essential oil.	198
10	Total ion chromatogram of <i>Ocimum basilicum</i> var. <i>purpurascens</i> essential oil.	200
11	Total ion chromatogram of <i>Origanum majorana</i> essential oil.	202
12	Total ion chromatogram of <i>Otostegia fruticosa</i> essential oil	204
13	Total ion chromatogram of <i>Salvia schimperi</i> essential oil.	206
14	Total ion chromatogram of <i>Stachys yemenensis</i> essential oil	208
15	Total ion chromatogram of <i>Teucrium yemense</i> essential oil.	210
16	Total ion chromatogram of <i>Thymus serpyllum</i> essential oil.	212
17	Percent of major components of the selected Lamiaceae medicinal plants	216
18	α -Glycosidase inhibition by acarbose and essential oil from of four selected medicinal Lamiaceae plants.	235
19	Dendrogram based on 298 attributes of micro-and macromorphological characters using <i>jmp</i> program, showing the interrelationships between 16 taxa of Lamiaceae based on dissimilarity distance.	249
20	Dendrogram based on 141 essential oil components identified using <i>jmp</i> program, showing the interrelationships between 14 taxa of Lamiaceae based on dissimilarity distance.	253