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Exploring the Potential of Wild *Salvia macilenta* Boiss. of Oman as Nutraceuticals

Saleem Kaseemsaheb Nadaf*[1]., Jamal Al-Sabahi[2], Ali H. Al-Lawati[3], Almandhar Al-Mamari[1], Fatima Al-Kindi, Abdulaziz Al-Mawali[1], Houda Al-Ruqaishi[2] , Ahmed Al-Ghafri[2], Amina Al-Farsi[4], and Nadiya Abubakar Al Saady[1]

[1]*Oman Animal & Plant Genetic Resources Center (Mawarid), Ministry of Higher Education, Research and Innovation, Oman*

[2]*Central Instrumentation Laboratory, College of Agricultural and Marine Sciences, Sultan Qaboos University, Oman*

[3]*Natural and Medical Sciences Research Center, The University of Nizwa, Oman*

[4]*Life Science Unit, College of Science, Sultan Qaboos University*

ABSTRACT

Background: Several plant extracts are now prescribed as nutraceuticals for human ailments in developed countries like China, France, Germany, the UK, USA including Oman. The objective of this study was to investigate on morphological characteristics, chlorophyll content of leaves, leaf chlorophyll, essential oil, and its chemical compounds to examine the possibility of isolating its incipient chemical compounds commercially in wild *Salvia macilenta* Boiss.

Methods: Leaf samples of ten randomly selected Salvia plants were collected from two diversified wadi habitats. Edaphic features of the sites were recorded and their chemical contents, determined. Morphological characters were measured and chlorophyll contents, recorded. The essential oil (EO) was extracted and analyzed for chemical compounds. The data were statistically analyzed.

Results: Al-Khoud plants had higher expressivity in all the morphological characters and chlorophyll contents than those of Halban. The EO yields of Salvia macilenta were 0.06 % (v/w) and 0.088 % (v/w) for the plant samples of Al-Khoud and Halban, respectively. The values of commonly occurring chemical contents of plants of two sites were found statistically similar ($p<0.05$). The top ten chemical compounds of plants contributed over 75% of the total and were common with seven chemical compounds. Of the ten top chemical compounds, alpha-Pinene, beta- Eudesmol, and Nerolidol contributed the highest in the same range from 61.13% (Al-Khoud) to 62.95% (Halban). These three compounds have the potential for use in both the pharmaceutical and perfumery industries.

Conclusion: Wild Salvia plants can be exploited with Good Agriculture Practices for their medicinal and aromatic application.

Corresponding Author e-mail: saleem.nadaf@moheri.gov.om or Saleem_nadaf@hotmail.com

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INTRODUCTION

Since the onset of civilizations in the world traditional medicine involving medicinal plants is under use directly or indirectly for the treatment of several ailments from which humans suffer. Of late, medicinal plant products have been found common in use either alone or in combination with allopathic medicine as nutraceuticals[1-2]. As a result, several plant extracts such as essential oils are now used alone or in combination with other medicinal products as nutraceuticals for human ailments in developed countries like China, France, Germany, the UK, USA[2]. In several parts of the world, traditional plant-based medicines are being integrated into mainstream health systems as evidenced by their trade worth US$ 60 billion in the year 2000 which is expected to reach US$ 5 trillion by 2050[3]. The distinctive global position in the south of Asia and north of African continents offers Oman the physiographic and climatic features of both continents that favor a range of socio-economic plant species. Oman has 1578 species of which 421 are medicinal plant species[4]. These include aromatic Salvia macilenta (Lamiaceae) which is also known for its medicinal properties[5-6]. This is wildly found in wadi habitats across all the governorates of Oman. Recently, many studies have indicated that Salvia species including Salvia macilenta L. have antioxidant properties and neuroprotective effects and exhibit antiglycation activity and also their plant-based medicinal product is effective for several ailments[7]. Hence the chemical contents of *Salvia macillenta* plants from two wadi habitats of Oman were investigated for their commercial exploitation as nutraceuticals.

KEYWORDS:
Morphology,
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MATERIALS AND METHODS

Plant Material

The required amount of leaf samples of *Salvia macilenta* L. was randomly collected around the sites in the winter season between November and February 2021 from the wadi habitat of Al-Khoud (58.1313 E; 23.51828 N) of wilayat Seeb of Muscat governorate located at the altitude of 127 m and also from the high mountain wadi site of Halban (58.07489 E; 23.52408 N) of Wilayat Al-Barka of South Batinah governorate (Fig. 1; Plate 1 (a-f); Table 1). Simultaneously relevant features of edaphic factors of locations like soil type, structure, important chemical contents, soil pH and salinity, and characters of plants were recorded. The voucher specimens of *Salvia macilenta* L. were confirmed by the taxonomist at the Sultan Qaboos University Herbarium (SPUH) of the Life Science Unit of Sultan Qaboos University, Oman. The voucher material of Al-khoud was deposited in the herbarium collection under barcode SQUH00006305 (https://herb.squ.edu.om/view_image/TkVyaStvZWFWL25yKzdIUWtHRUpVZz09). The composite plant samples were dried in the shade until their further use for the extraction of essential oil and chemical analyses.

Ten random plants were randomly selected for recording observations from each site. Plant traits namely plant height (m) from the base of the plant to the highest of tip the plant and two plant widths (m), one (W1) from north to south direction (n-s) and the other (W2) from east to west (e-w) were measured. The chlorophyll contents of leaf samples were measured using an atLEAF CHL PLUS chlorophyll meter[8]. Approximate plant area (m^2) was computed by multiplying plant height (m) with the mean of two plant lengths (H x (W1+W2)/2) and plant volume was calculated using plant height, and the two plant lengths as HxW1xW2. The edaphic characteristics of habitat and soil were recorded for the two wadi habitats (locations), and the range of chemical contents was determined with the use of S1 Titan/Tracer 5/CTX equipment[9]. In the present report, only selected macro- and micro-elements relevant to plant nutrition are presented here (Table 1).

Essential oils Extraction and their analysis

ETHOS X's advanced microwave extraction system was used to extract essential oils of Salvia macilenta[10] while analysis of essential oil was completed using GC-MS analysis on a Shimadzu GC-2010 Plus Gas chromatograph. The chemical compounds were detected by comparing the obtained spectra with mass spectrum libraries (NIST 2011 v.2.3) together with arithmetic retention indices on the capillary column and relative to a homologous series of n-alkane C7-C40. Finally, the results were confirmed by comparing the calculated retention indices with published literature.

Statistical Analysis

The standard errors (S.E. ±) were calculated from the n observations wherever applicable in the study. The sample means of 18 chemical contents commonly present in the essential oils of two locations were compared for differences by applying the paired Student's *t*-test at a $p<0.05$ using the data analysis feature of the Excel 16 version.

RESULTS

Soil Characters

The two locations have typical wadi habitat features. The Al-Khoud site is at a low altitude (127 m) whereas that at Halban is at a higher elevation (538 m) in the mountain ranges. In both wadis, the plains at the foothill consisted of sandy soil with particles coarser with differential colors from black to yellowish, and at some places dark reddish colored

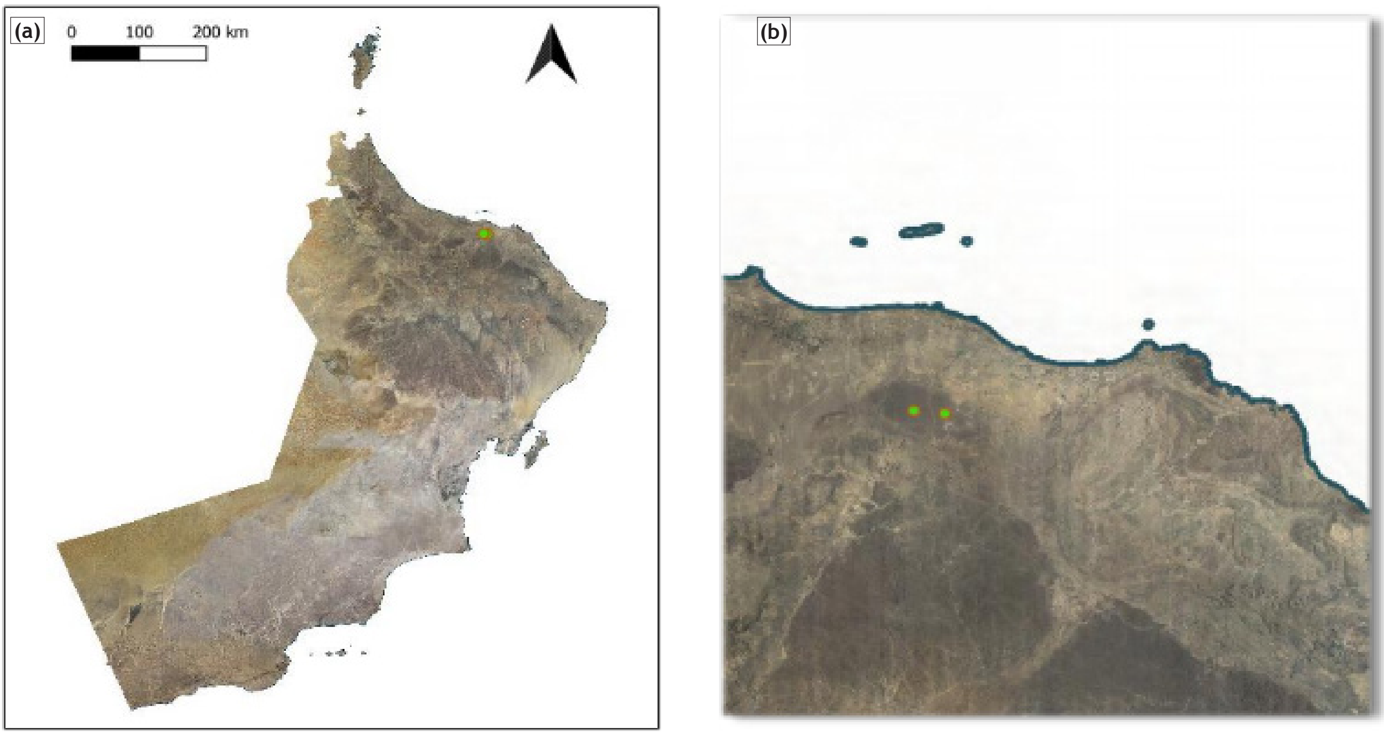

Fig. 1: General map of Oman (a) and the zoomed two green dot locations (b) in Muscat and North Al-Batinah governorates

Plate 1a: General view of the plant in wadi habitat

Plate 1b: The slender stems with transformed leaves

Plate 1c: Closer view of rudimentary leaves and inflorescences

Plate 1d: Inflorescences (closer view)

Plate 1e: Inflorescence and flowers

Plate 1f: Opened flower (closer view)

Plates 1 (a-f).: Images of *Salvia macilenta* L. plant found in the wadi habitats of the Sultanate of Oman granite-like materials. The rocks appear partly exposed with little soil covered with vegetation of small creeping herbs, smaller herbs, and medium to larger shrubs, which are mainly restricted to inner crevices or small depressions with fine sediments. The soil of both sites is formed of more than 95% coarse sandy particles.

Table 1: GPS data and main soil element contents (ppm) of two wadi locations from where Salvia macilenta leaf samples were collected

Element	*Al-Khoud*	*Halban*
Longitude (E)	58.1313	58.07489
Latitude (N)	23.51828	23.52408
Altitude (m)	127	538
	ppm	ppm
Nitrate (NO3)	100.0	69.0
Phosphorus (P)	11.1	18.2
Potassium (K)	89.1	200.2
Magnesium (Mg)	4734.9	1500.3
Calcium (Ca)	1858. 2	2890.6
Sulphur (S)	Traces	Traces
Iron (Fe)	2768.1	6127.8
Manganese (Mn)	12.3	56.8
Copper (Cu)	5.3	9.0
Silicon (Si)	12085.8	15129.6
PH	8.7	7.8
EC(Electrical Conductivity) (dS -1)	0.340	1.072

The soil material of both wadis has different pH and EC (Electrical conductivity); Alkhoud had soil with higher pH (8.7) than that of Halban (7.8). On the other hand, Halban had an EC of 1.072 dSm^{-1} indicating the influence of dryland salinity whereas Al-Khoud had a low EC of 0.340 dSm^{-1}. Soils of the wadi site near Halban have fairly higher contents of silicon (15129.6 ppm), iron (6127.8 ppm), calcium (2890.6 ppm), and potassium (200.2 ppm) than those of Al-Khoud. However, the soils of Al-Khoud have a higher amount of magnesium (4734.9 ppm), nitrate (538 ppm), and nitrate (100 ppm) than those of Halban. (Table 1).

Plant Morphological Characteristics

The plants of *Salvia macilenta* from Alkhoud had higher expressions of all the attributes than those of Halban except for stem thickness (Table 2) in respect of plant height (0.60 m vs 0.34 m) with the N-S canopy width (0.94 m x 0.59 m) and E-W canopy width (1.34 m x 0.83 m), canopy area (1.26 m^2 vs 0.49 m^2) and volume (0.76 m^3 x 0.17 m^3). The data on chlorophyll content in terms of atLEAF value indicated the satisfactory health status of salvia plants in both locations (around 60).

Essential oil recovery and Chemical Composition:

*T*he results of the analyses of essential oils of *Salvia macilenta* from two diverse locations in North Oman indicated different concentrations of a range of chemical constituents/ compounds. The yield of E.O. (% v/w) was 0.06% (0.3 ml/500 g) for the sample of Al-Khoud and 0.088 % (0.44 ml/500 g for the Halban sample of *Salvia macilenta (Tables 3 and 4)*. In the

Table 2: Morphological characteristics of *Salvia macilenta* at two locations of their samples' collection

Sl. No.	*Characters*	*Al-Khoud*	*S.Em. (±)*	*Halban*	*S.Em. (±)*
1.	Plant Height (m)	0.60	0.013	0.34	0.011
2.	*Plant length (N-S) (m)	0.94	0.014	0.59	0.016
3.	*Plant length (E-W) (m)	1.34	0.012	0.83	0.008
4	Approximate plant area (m2)	1.26	-	0.49	-
5	Approximate plant volume(m3)	0.76	-	0.17	-
6	Chlorophyll (atLEAF value)	60.00	0.019	59.00	0.021

Table 3: Chemical composition of *Salvia macilenta* composite leaf sample from Wadi Al-Khoud Al-Seeb Wilayat, Muscat governorate, Oman[ł]

Sl. No.	*Compound Name*	*R.T. (min)*	*Area*	*Area %*	*KI*
1	alpha.-Pinene	7.826	140569367	25.496	941
2	Nerolidol	23.495	69365628	12.581	1559
3	.beta.-Eudesmol	25.524	50778073	9.210	1655
4	trans-Nerolidol	23.541	46623581	8.456	1561
5	.beta.-Pinene	8.982	32972961	5.981	984
6	D-Limonene	10.397	25527851	4.630	1035
7	Linalool	12.313	17434172	3.162	1105
8	.alpha.-Eudesmol	25.572	14826603	2.689	1657
9	Camphol	14.156	14510243	2.632	1173
10	Camphene	8.22	13861544	2.514	956

Sl. No.	*Compound Name*	*R.T. (min)*	*Area*	*Area %*	*KI*
11	Isocaryophyllene	20.496	9791258	1.776	1426
12	Aromandendrene	20.943	9245361	1.677	1445
13	Caryophyllene oxide	24.145	9116704	1.654	1589
14	Borneol, formate	15.782	7179032	1.302	1235
15	p-Cymene	10.28	6751139	1.224	1031
16	Butanoic acid, 2-methyl-, 2-methylbutyl ester	12.424	6341062	1.150	1109
17	Levo-(-)-camphor	13.593	5083993	0.922	1152
18	delta.-Cadinene	22.779	5024852	0.911	1526
19	(+)-.alpha.-Bisabolol	25.197	4281074	0.776	1639
20	2-Camphanol acetate	17.226	4243818	0.770	1291
21	erythro-(cis)(1,4),(cis)(1',4')-4,4'-Dihydroxybicyclooctyl	33.035	3879580	0.704	2057
22	2-Methylbutyl isobutyrate	10.027	3278452	0.595	1022
23	Butanoic acid, 2-methylbutyl ester	11.183	3115731	0.565	1064
24	Isoamyl butanoate	11.111	3115038	0.565	1061
25	.tau.-Cadinol	25.282	3061342	0.555	1643
26	.gamma.-Cadinene	22.599	3035410	0.551	1518
27	4-Terpineol	14.442	2952472	0.536	1183
28	iso-Amyl iso-butyrate	9.926	2670464	0.484	1019
29	.gamma.-Terpinene	11.227	2327276	0.422	1065
30	Ledol	23.797	2087816	0.379	1573
31	.beta.-Myrcene	9.346	2065265	0.375	997
32	.gamma.-Eudesmol	24.909	1985341	0.360	1625
33	alpha.-Cubebene	19.443	1958080	0.355	1381
34	.gamma.-Muurolene	21.757	1737680	0.315	1481
35	.beta.-Ocimene	10.914	1661341	0.301	1054
37	Manoyl oxide	31.928	1636260	0.297	1995
38	Isopentyl propionate	8.759	1578854	0.286	976
39	.beta.-Eudesmene	22.017	1566251	0.284	1492
40	Palmitic acid, methyl ester	30.482	1554867	0.282	1911
41	L-Pinocarveol	13.429	1538654	0.279	1146
42	Ledene	22.202	1517851	0.275	1500
43	2-Methylbutyl propionate	8.822	1503414	0.273	978
44	U.I	22.983	1492417	0.271	1536
45	Spathulenol	24.01	1434078	0.260	1583
46	Eucalyptol	10.475	1406347	0.255	1038
47	L-.alpha.-Terpineol	14.786	1398465	0.254	1196
48	Selina-5,11-diene	21.034	1160517	0.210	1449
49	1,1,3a-Trimethyl-7-methylenedecahydro-1H-cyclopropa[a]naphthalene	20.691	1091906	0.198	1434
	Total		551339485	100.000	-
Essential oil recovered	0.06 % v/w				

[1]RT –Retention Time (minutes); KI- Distribution Constant; UI-Un-identified (not detected)

present study, 48 chemical compounds of *Salvia macilenta* were identified in the range from 0.198 % (1,1,3a-Trimethyl-7-methylenedecahydro- 1H-cyclopropa [a]naphthalene) to 25.496 % (Alpha-Pinene) and 0.169 % (Isogermacrene D) to 30.768 % (Alpha-Pinene), respectively for the Al-Khoud and Halban samples.

Table 4: Chemical composition of *Salvia macilenta* composite leaf sample from wadi Halban of Al-Barka Wilayat, South Batinah Governorate, Oman

Sl. No.	*Compound Name*	*R.T. (min)*	*Area*	*Area %*	*KI*
1	alpha.-Pinene	7.845	94907353	30.768	942
2	.beta.-Eudesmol	25.561	39799627	12.903	1657
3	D-Limonene	10.411	20243970	6.563	1036
4	Camphene	8.232	16795114	5.445	956
5	trans-Nerolidol	23.559	13780267	4.467	1562
6	Nerolidol	23.512	12180026	3.949	1560
7	.beta.-Pinene	8.993	11048172	3.582	984
8	Alloaromadendrene	20.96	9964727	3.230	1446
9	endo-Borneol	14.171	7964554	2.582	1173
10	Linalool	12.325	6648964	2.156	1105
11	p-Cimene	10.292	5859941	1.900	1031
12	L-camphor	13.604	5401856	1.751	1152
13	Bornyl acetate	17.236	4969850	1.611	1291
14	(Z)-.beta.-Caryophyllene	20.511	4526849	1.468	1427
15	2-Methylbutanoic acid 2-methylbutyl ester	12.435	3798384	1.231	1109
16	Germacrene D	22.614	3570402	1.157	1519
17	erythro-(cis)(1,4),(cis)(1',4')-4,4'-Dihydroxybicyclooctyl	33.059	3566441	1.156	2045
18	Bornyl formate	15.794	3383822	1.097	1235
19	Cycloheptane, 4-methylene-1-methyl-2-(2-methyl-1-propen-1-yl)-1-vinyl-	22.222	3142520	1.019	1501
20	(-)-.beta.-Cadinene	22.797	2812343	0.912	1527
21	Chamigren	22.033	2682497	0.870	1493
22	n-Amyl ether	11.193	2303781	0.747	1064
23	Caryophyllene oxide	24.158	2273910	0.737	1589
24	Isoamyl butanoate	11.12	2004217	0.650	1061
25	.tau.-Cadinol	25.32	1746817	0.566	1645
26	Alloaromadendrene	23.099	1630677	0.529	1541
27	Manoyl oxide	31.951	1499446	0.486	1987
28	2-Metylbutyl Isobutyrate	10.037	1429001	0.463	1022
29	U.I	23.238	1301437	0.422	1547
30	Isoamyl isobutanoate	9.935	1276409	0.414	1019
31	Terpinen-4-ol	14.456	1251279	0.406	1184
32	Copaene	19.453	1142073	0.370	1382
33	Dimethylsiloxane pentamer	13.742	1108535	0.359	1157
34	Epicubebol	20.874	1092095	0.354	1442
35	Patchoulene	21.771	1043537	0.338	1481
36	Aromandendrene	20.703	1018536	0.330	1435
37	Bicyclo[5.3.0]decane, 2-methylene-5-(1-methylvinyl)-8-methyl-	21.046	958006	0.311	1450
38	alpha.-Campholenal	13.083	934630	0.303	1133
39	Camphene	8.386	898005	0.291	962
40	2-Methylbutyl propionate	8.832	775703	0.251	978
41	Propionic acid, pentyl ester	8.768	775007	0.251	976
42	L-Pinocarveol	13.443	749105	0.243	1146
44	Humulene	21.29	698957	0.227	1460

Sl. No.	*Compound Name*	*R.T. (min)*	*Area*	*Area %*	*KI*
45	U.I	21.946	674134	0.219	1489
46	Pinocarvone	14.092	665145	0.216	1170
47	Cabreuva oxide B	21.396	548665	0.178	1465
48	Butyric acid, 2-methyl-, isobutyl ester	9.674	548104	0.178	1009
49	Tricyclene	7.517	544081	0.176	930
50	Isogermacrene D	20.81	519913	0.169	1440
	Total		308458884	100.000	
Essential oil recovered	0.088 % v/w				

▫ RT –Retention Time (minutes); KI- Distribution Constant; UI-Un-identified (not detected)

Table 5: Chemical contents (Area %) of *Salvia macilenta*, which are common in the plant samples of Al-Khoud and Halban, Muscat Governorate

Sl.No.	*Compound name*	*Al-Khoud*	*Halban*
1	beta.-Eudesmol	9.210	12.903
2	beta.-Pinene	5.981	3.582
3	tau.-Cadinol	0.555	0.566
4	2-Methylbutyl propionate	0.595	0.251
5	2-Metylbutyl Isobutyrate	0.273	0.463
6	alpha.-Pinene	25.496	30.768
7	Aromandendrene	1.677	0.330
8	Camphene	2.514	5.445
9	Caryophyllene oxide	1.654	0.737
10	D-Limonene	4.630	6.563
11	erythro-(cis)(1,4),(cis)(1’,4’)-4,4’-Dihydroxybicyclooctyl	0.704	1.156
12	Isoamyl butanoate	0.565	0.650
13	Linalool	3.162	2.156
14	L-Pinocarveol	0.279	0.243
15	Manoyl oxide	0.297	0.486
16	Nerolidol	12.581	3.949
17	p-Cymene	1.224	1.900
18	trans-Nerolidol	8.456	4.467
	Total	79.853	76.615

Stability of chemical composition

Of the total chemical contents (49-50) of the plant samples of two locations, only 18 chemical contents were common (Table 5). These chemical contents were found to be statistically similar based on the results of paired t-test performed ($p<0.05$) (Table 6).

Contribution and Composition of top ten chemical compounds

The top ten higher contents of the Al-Khoud sample accounted for 77.35 % of its essential oil recovered (Table 3) whereas the sample collected from Halban accounted for 75.65 % of its essential oil (Table 4). Of the top ten higher contents of the sample of Wadi Al-Khoud, alpha-Pinene occupied the highest to the extent of 25.496 % of the area (concentration), followed by

Table 6: Results of paired t-test performed for the 37 common chemical contents of essential oils of the plant samples of *Vitex agnus castus* from two geographically diverse locations of Oman

Location	*Al-Khoud*	*Halban*
Mean	4.436	4.256
Variance	40.747	54.101
Observations	18	18
Pearson Correlation	0.913660278	
Hypothesized Mean Difference	0	
df	17	
t Stat	-0.253615152	
P(T<=t) one-tail	0.401417337	
t Critical one-tail	1.739606726	
P(T<=t) two-tail	0.802834674	
t Critical two-tail	2.109815578	

Nerolidol (12.581 %), beta Eudesmol (9.210 %), trans Nerolidol (8.456 %) and beta-Pinene. On the contrary, of the top ten higher contents of the Halban sample, alpha-Pinene accounted for the highest of 30.768% of the area (concentration), followed by beta Eudesmol (12.903 %), D-Limonene (6.563 %), and Camphene (5.445%).

DISCUSSION

The present investigation addressed the possibility of exploiting wild *Salvia macilenta* Boiss for the future utility of its major chemical compounds in pharmaceuticals considering its morphological characters, chlorophyll, and chemical contents in two diverse sites. The results indicated differential expression of Salvia plants in two diverse sites in terms of a few morphological characters related to the area and volume of the plant and chlorophyll contents. The plant height (0.34 -0.60 m) observed in the present study was comparable to the only study addressed to morphological characteristics of other species of *Salvia L. taxa*[11] namely *S. verticillata* subsp. *amassiaca* (0.5 -0.8 m), *S. tomentosa* (0.55-0.90 m), *S. virgata* (0.32-0.90 m), *S. forskahlei* (0.36-0.90 m) and *S. sclarea* (0.85-1.35 m). In this study, wild plants were evaluated in terms of chlorophyll content in relation to plant nutritional status[8]. Such results on growth, yield, and yield-related parameters from agronomic experiments assist scientists in deciding on inter-plant spacing to adopt good agriculture practices (GAP)[12] for maximizing the herbage yield.

There are no reports so far on the essential oil yields of *Salvia macilenta* plants. The present study reported a very low range of essential oil yield for the wild plants from two locations (0.06-0.088% v/w). However, a range of essential oil yields is reported for other species of *Salvia*, namely *S. glutinosa* (0.03-0.05%[13]), *S. dichroantha* L. (0.19%[14]), *S. hydrangea* (0.25 to 0.28%[15]), *S. sclarea* (0.5%[14]), *S. officinalis* (0.93%[16]) and 1.68%[17]), *Salvia mirzayanii* Rech.f & Elmond (2.2%[18], *S. fruticosa* (3.86%[14]) and *S. aramiensis* (5.31%[17]). The low levels of essential oil synthesis in wild Salvia macilenta plants observed in the present study can be increased through elicitation as observed recently in Ocimum gratissimum L.[19].

The top seven compounds obtained in samples of both locations were similar, irrespective of the magnitude of their concentrations. These results were comparable with the previous results in *S. macilenta* in respect of higher contents of alpha-pinene (36.4% and 29.00%), Eudesmol (8.6 to 16.4% and 8.7%) and Nerodilol (3.95 to 8.46%)[20].

Regarding essential oils, alpha-pinene (30.77% and 25.50%), and Beta Eudesmol (12.91% and 9.21%) were found in a higher concentration of chemical compounds namely in the plant samples of wadi Halban and Al-Khoud, Among the Salvia species, Alpha-Pinene constituted the most abundant chemical compound in the essential oils of Salvia rosifolia[21](19.7%), *Salvia divaricate*[22](10.2%) and *Salvia recognita*[23](7.6%). Alpha Eudesmol was one of the main chemical compounds in *Salvia microphylla*[24] (14.1%) and *Salvia africana* [25](10.7%). *Salvia macilenta* is also known to have antibacterial and antimycotic properties[6]. Given the merits of compounds abundantly available in *Savia macilenta*, as stated above, it is recommended that this medicinal plant species be explored for the isolation of plant-based molecules for their safe utilization for human welfare. The isolation of molecules can be considered commercially feasible on a large scale by producing large green matter of the plants by growing *Salvia macilenta* in the field with good agriculture practices (GAP) formulated using specific plant characteristics like approximated plant area (m^2) and plant volume (m^3) for optimum plant density besides irrigation scheduling and fertilizer management[12, 26].

CONCLUSION

The wild *Salvia macilenta* plants express their morphological features, essential oil, and its chemical contents variably depending upon the geographic locations. These wild plants can be domesticated by growing them in farms with good agriculture practices (GAP) to produce optimum biomass for the extraction of the higher amount of essential oil towards isolation of valuable medicinal compounds like alpha-Pinene.

Ethical approva: Ethical approval is not required for our research.

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Authorship contributions

SKN planned the investigation, statistically analyzed the data and written the original draft and modified/revised based on inputs of all other authors. JNA and AHA devised and helped in the chemical analysis and collection and preservation of plant samples, respectively. ARA and AAA collected seed and plant samples. FAA, HKA and ASA helped in extraction of essential oil and its chemical analyses. AF confirmed the specimens as that of *Salvia macilenta* Boiss and NAS arranged for funds and supervised the investigation.

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