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VOLATILE CONSTITUENTS OF THE AERIAL PAR OF *STACHYS SPECTABILIS*

M.H.Meshkatalsadat[*] and R Amini Radpoor

Department of chemistry, Faculty of Basic Sciences, Qom University of technology Qom, Iran

***Corresponding author*:** MH Meshkatalsadat

ABSTRACT: The essential oil of the aerial parts of Stachys *spectabilis* (Lamiaceae) were isolated by hydro-distillation. The chemical composition of volatile oil was analyzed by capillary GC and GC/MS. Twenty five compounds were identified representing 99.37% of the total components detected. The main components were found to be: Cembrene (32.97%), Longiborn-8-ene (30.1%), Valencene (8.48%), 2-pentyl-2-cyclopentene-1-one (6.26%), α -Bisabolene (5.41%).

***Keywords*:** *Stachys spectabilis*; Lamiaceae; Essential Oil; HD.

INTRODUCTION

The purpose of this paper is to give a brief taxonomy of an important group of programming problems which occur in certain branches of applied mathematics. A rough heading for these problems is “Modeling of Mathematical Programming Problem”. Here special emphasis is given on multi-objective optimization problem. It is no accident that the principal source of such problems is multiple decision-making in which the action space is of a multi-objective nature. Iterative approaches involving interactions with decision makers have often been advocated in multiple criterion optimizations as well as in the specification of politician’s preferences in macro-economic decisions involving multiple objectives.

Traditional mathematical programming models are based on the assumption that the decision making has a single, quantifiable, objective such as maximization of profit or minimization of inefficiency or cost. However, often there are situations, where instead of posing a single objective, managers use comparative criteria in decision-making. Thus, instead of setting only one objective, multiple goals in form of linear may be set. Specification of multiple goals creates difficulties in the solution to a given problem because the objectives are usually conflicting and incommensurate.

Many researchers have proposed algorithms for solving mathematical programming problem, for example: Charnes and Cooper (1962), Martos (1975), Wolf(1985) and others. Comparative investigations of such algorithms can be found in Arsham and Kahn (1990) and Bhatt (1989). Additional information concerning especially the ‘bad points (A point x^l is called a bad point if $f(x)$ tending to infinity when x tending to x^l) is studied by Verma, Khanna and Puri (1989).

For the first time an elimination algorithm is modeled for numerical solution of multi-objective linear programming problem by using Williams (1986), Kanniappan and Thangavel (1998), Jain (2009) work’s in modified form for MOLPP by using Fourier method. Our aim is to reduce the computing time of the optimization process of the proposed problem in which multi-objective function treated as constraints in nature. These constraints are encountered in transportation, flow and network models. It is assumed that the set of the feasible solutions is a convex polyhedral with a finite number of extreme points and that the denominator of the quotient function is non-zero on the constraint set.

EXPERIMENTAL

Plant Material and Isolation of essential oil Procedure

The plant material was collected at May 2012 during the flowering period at an altitude of 2500-3000m, Iran. The voucher specimen was deposited at the Herbarium of the University The oils were obtained by hydro-distillation using a Clevenger-type apparatus for about 4 h and dried over sodium sulfate. The yield of the oil obtained from of *S. spectabilis* 0.21%.

GC/MS analysis

GC/MS analysis of the oil was carried out on an Agilent HP-6890 gas Chromatograph (Agilent Technologies, Palo Alto, CA, USA) equipped with an Agilent HP-5973 mass selective detector in the electron impact mode (ionization energy: 70eV), operating under the same conditions as described above, using a HP-5MS 5% phenylmethylsiloxane capillary column (30 m × 0.25 mm, 0.25 μm film thickness; Retention indices were calculated for all components using a homologous series of n-alkanes injected in conditions equal to the sample one. Identification of components of essential oil was based on retention indices (RI) relative to n-alkanes and computer matching with the Wiley7n.L libraries, as well as comparisons of the fragmentation pattern of the mass spectra with data published in the literature (Adams R.P.,2001). Some commercially available components of the essential oil were also co-injected for further confirmation of their identification.

RESULTS AND DISCUSSION

Chemical composition

Chemical compositions of the hydro-distillated oil is shown in Table 1. In the full flowering 25 compounds were identified with major compounds being: Cembrene (32.97%), Longiborn-8-ene (30.1%), Valencene (8.48%), 2-pentyl-2-cyclopentene-1-one (6.26%), α -Bisabolene (5.41%).

CONCLUSION

Chemical compositions of the hydro-distillated oil is shown in Table 1. Twenty Five compounds were identified representing 99.37% of the total components detected with major compounds being: Cembrene (32.97%), Longiborn-8-ene (30.1%), Valencene (8.48%), 2-pentyl-2-cyclopentene-1-one (6.26%), α -Bisabolene (5.41%). The oil of *S. spectabilis* consisted mainly of oxygenated monoterpenes (0.0%) ,hydro- carbonated monoterpenes (0.0%), sesquiterpenes (7.4%), oxygenated sesquiterpenes (2.08%), diterpenes (32.97%), and others (57.55%). Previous studies on volatile oil of members of the *Stachys* shows various components. β-caryophyllene, one of the main components of *S. aleurites* (Flamin, G, 2005) α-copaene was detected as the dominate fraction in the oil of *S. byzanthin* (Khanavi, M, 2003). α-pinene and β-caryophyllene are the major component of *S. lavandulifolia* Vahl. were collected from Tehran of Iran and Turkey, respectively (Feizbaksh A. 2003) In the oils of *S. oblique* (Harmandar, M, 1997), *S. laxa* Boiss (Sajjadi, SE, and Mehregan, I, 2003), *S. cretica*, *S. scardica*, *S. germanica* (Skaltsa, H.D 2003), germacrene-D are recorded as the major constituent. In the oils of most *Stachys* species, however, *S. laxa* oil is characterized by a high content of sesquiterpenes (78.6%) with germacrene-D (40.8%) and β-caryophyllene (16.7%) as major components.

Table 1. Composition of the essential oil of *Stachys spectabilis*

row	Compound	KI	Percentage
1	Yomogi alcohol	0999	0.83
2	α -Compholenal	1126	0.45
3	2-pentyl-2-cyclopentene-1-one	1290	6.26
4	Eugenol	1359	0.36
5	β -Damascenone	1385	0.22
6	Germacrene	1485	0.76
7	β -Ionone	1489	0.31
8	Valencene	1496	8.48
9	Bicyclogermacerene	1500	0.44
10	α -Bisabolene	1506	5.41
11	α -Farnesene	1506	0.39
12	δ-Cadinene	1523	0.52
13	Nerolidol	1563	1.14
14	1,3- Cyclooctadiene		0.49
15	Ledol	1569	0.28
16	Caryophyllene oxide	1583	2.70
17	Veridiflorol	1593	1.25
18	Longiborn-8-ene	1599	30.1
19	Humulene epoxide(II)	1608	0.32
20	3-Hexenyl phenyl acetate	1634	2.55
21	α -Cadinol	1654	0.20
22	Dihydro-aplotaxene	1655	0.45
23	Valeranone	1675	1.38
24	Farnesol	1725	0.94
25	Cembrene	1949	32.97
	Total		99.37

KI=Kovat's retention
indices as determined on as DB-1 column using the homologous series of n-hydrocarbons.

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