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The Investigation on Drug Yield and Some Quality Characteristics of Mountain Tea (*Sideritis congesta*) Cultivated in Turkey

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Abstract: This research has been conducted under Konya ecological conditions to determine the effect on yıeld and quality some characters of nitrogen fertilizers applied at the different doses of *Sideritis congesta* in Medicinal Plants laboratory and Medicinal Plants Experimental Farm of Agriculture Faculty, Selcuk Universty. Experiment was designed and applied in randomized complete plotdesign with three replications in the year of 2012-2013. According to results of this researh; the plant height of *Sideritis congesta* was varied between 58.66-64.33 cm, the number of flowering branches 49.00-55.00, fresh flowering yield 446.66 - 623.33 kg/da, essential oil yield 0.24-0.33 % and major essential oil component (β –pinene) 43.24 and 48,45. The highest drug flower yield and essential oil yield for mountain tea in Konya and similar ecology 10 kg/da nitrogen fertizer application is reasonabled.

Keywords: Mountain tea, *Sideritis congesta*, Essential oil, β –pinene, Fertilizer

1. INTRODUCTION

Mountain tea (*Sideritis congesta* et Huber-Morath) is a perennial plant which belongs to the Labiatae / Lamiaceae family. Lamiaceae family plants are grown in almost every habitat types and altitudes spreading out in a wide area from the North Poleto the Himalayas, South East Asma, Hawaii and Australia, Africa and America, but actually grown in the Mediterranean region [1]. Showing a wide distribution in our country and the world, the *Sideritis* species which are an important species of Labiatea family, are represented by approximately 150 taxon species of annual and perennial plants especially grown in the Mediterranean basin and the world [2] as well as by 54 species and sub-species, 41 of which are endemic (78%) especially grown in Mediterranean region of Turkey [3]. *Sideritis congesta* is endemic to Turkey and located in natural flora of our country. Most types of the endemic mountain tea species in our natural flora, especially the *Sideritis congesta* to the point of extinction as a result of uncontrolled, intensive, continuous and unconscious collected from the flora where they are naturally grown. The mountain tea species naturally grown in our country are the species in the hairly or rarely glabrous structure with or without secretory glands, simple leafed, fulled gedcrenata-dentate and stalked or stemless perennial herbs or small shrubs, consisting of erected and four-cornered stems [4-5]. The mountain tea species (*Sideritis* spp.) are not cultivated in our country. The mountain tea species (*Sideritis* spp.) whose consumption has been rapidly and increasingly are collected from natural flora in our country. The mountain tea species continuously collected

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from nature do not have good yield and quality, so are not sustainable. Drug plant at high quality and economic values cannot be produced from the mountain tea species collected from the natural flora because of the fact that these species are not collected, dried and stored in a suitable time. Expected effect cannot be achieved by consumption of the mountain tea species collected from the nature as they are not standardized in terms of physical, chemical and biological values. A great number of chemical studies have been conducted on the mountain tea species, mainly focus on essential oils, diterpenes and flavonoids [6-7-8]. In addition to such studies, there are also pharmacological studies conducted on the *Sideritis* species [9-10]. In addition to studies on their biological activity, some recent studies have especially been conducted on their anti-inflammatory, analgesic, diuretic, antiulcer, anti-depressants, antimicrobial and insect-repellent effects [11-12]. Also, antispasmodic effects of *Sideritis congesta* and *Sideritis arguta* have been reported [13]. The mountain tea species are used as tea form in the treatment of certain diseases due to their anti-inflammatory, antirheumatic, digestive and antimicrobial activity properties [14]. *Sideritis* species are widely consumed as herbal tea due to their aroma profiles. *Sideritis* species are publicly known to have sedative, antitussive, digestive system regulatory and anti-inflammatory effects [15]. When the yield of the mountain tea flowers consumed by the public as a tea is considered, the yield of fresh flower per decare was observed to be higher than 1 tone irrespective of applied plant density, but more than 1.5 tone in many densities. Average drug flower yield was reported to range between 348-419 kg/da [16]. In this study the yields were determined as 1567-2404 kg per decare for fresh herba and 530-629 kg drug herba but varying depending on the plant density [16]. This study aim was determined to drug yield and some quality parameters of cultivated *Sideritis congesta* which is one of the important endemic species of Turkey.

2. MATERIAL and METHOD

The research has been done at Selcuk University Agriculture Faculty Medical Plants Research and Application Farm in Konya which is in the Central Anatolia region in Turkey, between 2012-2013 years. In this study, seeds that has been used were obtained from the collection that belongs to Department of Medical Plants. Properties of the soil of research farm are shown in the Table 1.

Table 1. Chemical and physical properties of the soil

Soil Proporties	Quantity
Clay (%)	18.3
Silt (%)	14.3
Sand (%)	67.4
Texture	Sandy loamy
pH (1:2.5)	8.1
EC (1:5) (µS/cm)	12.5
$CaCO_3$ (%)	31.3
Organicsubstance(%)	2.9
Suitable Cu (ppm)	0.2
Suitable Fe (ppm)	0.9
Suitable Mn (ppm)	2.4
Suitable Zn (ppm)	0.1
B (ppm)	0.2
P (ppm)	17.7
Field capacity(%)	22.5
Total N (%)	0.2

Note: *Soil analyses performed at S.Ü Agriculture Faculty, Laboratory of Department

When Table 1 is evaluated, it can be seen that the ground has loamy and sandy soil, is rich in lime and phosphorus. Also, it's organic ingredients at intermediate level, it has an alchali character and does not have saltiness problem. In addition, it is intermediate level in point of mangan and it is poor in terms of other trace elements. Climate datas that are belongs to the years that experiments done, 2012 and 2013 are given in the Table 2 with the datas from other years. In this study, trials have carried out with three repeats as the "Random Blocks Trial Design" in the fields of Selçuk University, Agriculture Faculty, Department of Medical Plants Research Farms. In this trial which planned as the "Randomized Blocks Trial Design", three different nitrogen doses (0, 5, 10 kg/da) were used. Mountain tea seedlings were planted as 60 cm squence intervals and 30 cm on top on 25th April 2012 in the field. Nitrogen fertilization was applied when the height of plants is 10-15 cm in mountain tea before the blooming period (%33 Ammonium Nitrate). During the growing period, study plots been irrigated 3 - 5 times according to climate conditions and the water need of mountain tea. It was cleaned to the weeds. The flower has been harvested from 50 cm on the top 10th September.

The height of the plant (cm) was determined as the height from ground surface to the highest point of the plant using 5 plants that has been chosen randomly when their growing reached its highest level. The number of branches with flower (number/branch) has been determined when the plant was in its blooming period and the plants that has been chosen randomly from every plot. Fresh flower yield (kg/da) was obtained by weighting the plants after side efficacy of the plots were thrown out. Fresh flower yields were determined by the calculations that were made through the plot yield. Drug flower yield (g) were designated by drying the 1000 g wet samples that was harvested from each and every plots, using three different drying methods (shadow, sun, drying oven). Drying rates were determined by weighing the remaining dry weights. Drying methods;

- Drying in shadow 6 days (144 h)
- Drying in oven 40^{o}C 2 days (48 h)
- Drying in The Sun 3 days (72 h)

Essential oil yield (%), dried samples were weighed 100 g. These samples were distilled 3 hours. Essential oil yield were accumulated by the Clevenger apparatus. Essential oil was put in bottles and it was given to the GS-MS device. Herbal essential oil yield (%) was calculated as the volume of the essential oil in the 100 g dry matter (ml/100 g). essential oil components (%) For determining the volatile oil components GC-MS device has been used. Essential oil components that belongs to every plant has been determined by using the parameters below. Identification of the essential oil components were studied based on Wiley and Nist Mass Spektral library datas. Statistical analyses using randomized blocks trial design, variance analyses have been done and according to these analyses average values that are important were grouped as "Least Significant Difference" (LSD). Statistical evaluations have been done by using Jump program.

Gas Cromatography mass spectrometry (GC-MS)

Machine: Agilent 6890N Network GC system combined with Agilent 5973 Network 30

Mass Selective Detector (GC-MS Agilent)

Colon: Agilent 19091N-136 (HP Innowax Capillary;60.0mx0.25mmx0.25 m)

Carrier Gas: Helium

Flow rate: 1.2 ml/min

Injection Volume: 1 µl

Split ratio: 50:1

Injection Tempature: 250°C

Tempature programme: 60-220-240

Scanning range (m/z): 35-450 atomic mass units (AMU)
Ionization: Electron bombardment (EI - 70 eV).

Table 2. Some climatic values for the long growing term (1980–2012) and for the term (2012–2013)

Months	Average monthly temperature level			Average monthly total rain fall (mm)			Average monthly relative humidity (%)		
	1980-	2012	2013	1980-	2012	2013	1980-	2012	2013
January	2,1	-0,3	1,6	38,6	0,0	33,7	78,0	78,4	80,6
February	3,6	-0,9	4,7	35,5	0,2	31,9	66,8	69,2	70,6
March	7,3	5,1	7,7	24,5	10,0	16,6	57,8	55,5	55,4
April	11,3	14,4	11,9	44,9	4,6	41,6	58,1	43,7	58,1
May	16,4	16,3	18,4	41,8	51,0	54,8	52,1	55,2	45,9
June	20,5	23,0	21,6	41,0	11,0	8,8	48,7	39,3	36,3
July	25,4	26,2	23,2	6,4	0,2	0,9	36,4	33,1	34,0
August	25,0	23,2	23,5	3,1	0,0	0,0	33,7	38,3	32,3
September	19,5	20,9	18,6	6,6	1,0	4,0	35,6	34,0	37,8
October	12,5	15,2		48,5	31,5		61,1	57,9	
November	6,7	7,8		17,1	39,1		65,6	78,0	
December	3,5	3,8		48,8	60,8		74,7	82,1	
Average	12,8	12,9	14,6				55,7	55,4	50,1
Total				356,8	209,4	192,3			

3. RESULTS and DISCUSSIONS

The variance analysis of the yield and some quality characteristics examined in the experiment are given in Tables 3. and 4.

3.1. Plant Height (cm)

In this study, the doses of fertilizer applied on *S. congesta* plant height were not obtained statistically significant. The highest plant height was obtained from 10 kg/da nitrogen application (64.33 cm). In this was obtained from control (60.66 cm) and plots (58.6 cm) applied with 5 kg/da nitrogen, respectively. By the reason that it is the first study related to the cultivation of mountain teas which are endemic plants in Turkey, the references has not been found within the scope of this subject.

3.2. Number of Flowering Brunch (number / plant)

In this study, the doses of fertilizer applied on the number of flowering branches per *S. congesta* plant were not obtained statistically significant. The number of flowering branches per plant was obtained from 55.00 pieces with nitrogen application 10 kg/da, this was followed by nitrogen application (50.30 pieces) with 5 kg/da and control plots (49.00 pieces), respectively. An significant increase in the number of flowering brunch for per plant was determined in with the doses nitrogen applied in this research.

3.3. The Yield of Fresh Flowers (kg/da)

In this study, the doses of fertilizer applied on the yield of wet flowers belonging to *S. congesta* plant were obtained statistically significant as 0.01 %. The highest yield of fresh flower was determined from nitrogen application (10kg/da). This was followed by nitrogen application (546.66 kg/da) with 5kg/da and control plot (446.66 kg/da) respectively. According to these results, the yield of fresh flower were significantly increased when the amount of applied nitrogen increases. It has been recorded 499-818 kg/da in the experiment with mountain tea [16].

3.4. Essential Oil Yield (%)

In this study, the doses of fertilizer applied on the essential oil of yield of mountain tea were obtained statistically significant. The highest essential oil yield was determined from shade dried application of control plots (0,33 %). This was followed by sun dried application of control plots (0,26 %). The lowest essential oil yield was determined from 10 kg/da nitrogen application of control plots and oven dried application (0,23 %). As a result, while the highest essential oil yield of samples was obtained by the shade-dried, the lowest essential oil yield of samples was obtained by the oven-dried method.

3.5. Essential Oil Compositions

The effect of fertilizer doses and drying methods applied on the essential oil components of *S. congesta* plant obtained from this study is statistically significant. The average percentage of β-pinene, the most important component of *S. congesta's* essential oil, varied between 43.2-48.4%. The highest amount of β-pinene was obtained from the control plots and from the drying methods of the sun, the lowest amount of β-pinene was obtained in 10 kg/da nitrogen treated plots and in a shade drying method. In this study; the amount of α-pinene from other important essential oil components varied from 29.2% to 33.9%. The amount of β-pinene, which is the major component of *S. congesta*, was also obtained by control plots and by the drying method of α-pinene. It can be said that nitrogen application in high doses increases the drug flower yield in mountain tea species such as *S. congesta*, but does not increase chemical composition of essential oil.

Table 3. The agronomic characteristics of *S. Congesta* cultivated at the different fertilizier doses

Fertilizier dose	Plant height (cm)	Number of flower branches (number/ flower bud)	Fresh flower yield (kg/da)
S.congesta 0 kg/da	60.6	49.0	446.6 b
S.congesta 5 kg/da	58.6	50.3	546.6 a
S.congesta 10kg/da	64.3	55.0	623.3 a
LSD	10.2	8.2	158.9

Table 4. Essential oil compositions (%) and yield values (%) obtained at different drying methods applied to *S. congesta*

Drying method	Essential Oil Yield	B-pinene	α-pinene	Linalool	Sabinene	GermacreneD
S.congesta (in the sun)	0.26	48.3	33.7	3.72	1.57	0.48
S.congesta incubator	0.24	47.7	32.6	3.45	0.60	1.37
S.congesta shadow	0.28	46.6	29.3	4.53	1.42	1.63
LSD		1.90	3.73			

4. CONCLUSION

According to our results, the plant height was varied between 58,66- 64,33 cm, the number of flowering brunch is 49,00-55 the yield of fresh flower is 446,66- 623,33 kg/da, the essential oil yield 0,23-0,33 ml/100 g and the yield of β–pinene in the main compounds of essential oil 43,24-48,45 % for *S. congesta*.

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Conflict of Interests

Authors declare that there is no conflict of interests.

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