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The Effect of Habitat Characteristics on the Essential Components of the Medicinal Plant *Stachys lavandulifolia* Vahl. in Kalakuh of Amol Rangeland

Zahra zamani, Reza Tamartash*, Qodratollah Heydari, Zeinab Jafarian Jelodar

Rangeland Department, Faculty of Natural Resources, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran

***Corresponding author: rezatamartash7@gmail.com**

Introduction

The growth and performance of plants in ecosystems are influenced by various factors, each of which can have a significant impact on the quantity and quality of plants, especially medicinal plants (Soltanipour, 2013). In various studies, although the synthesis of secondary metabolites in medicinal plants is under the genetic control of plants, environmental factors significantly affect their production and composition in plants (Mirazadi et al., 2014; Razmjou et al., 2015; Mohammadzadeh et al., 2015; Rahmanivahid et al., 2015; Arabsalehi et al., 2016; Zarali et al., 2016; Tavakoli et al., 2022; Bertome et al., 2007; Verma & Shukla, 2015). Several researchers investigated the effect of ecological factors on the performance of medicinal plants and stated that the change in the quantity and quality of the essential oil of medicinal plants is directly dependent on the soil factors that affect the quantity and amount of components of the essential oil (Mortonfi et al.,1994; El_Alam et al., 2019; Rapposelli et al., 2015). Therefore, considering the high potential of the studied habitat in terms of exploiting medicinal plants and the significant distribution of medicinal plants in the region, especially the *Stachys lavandulifolia* plant, and the significant role of environmental factors on the amount and quality of the essential oil of medicinal plants, in this research, it is tried to determine the effect To compare and investigate the environmental factors on the quantity and quality of the essential oil of *Stachys lavandulifolia* species in the Nemarstaq Amol region in the northern and southern aspects.

Material and Methods

The studied area is located at a distance of 82 km from the southwest of Amol city of Mazandaran province and was part of summer rangeland. in order to investigate the effect of environmental factors on the phytochemistry of the medicinal species *Stachys lavandulifolia* Vahl. The aerial organs of the adult plant were collected during the full flowering season (end of June 2022). According to the patchy distribution of the plant in the field, sampling of the plant and soil (from 0 to 30 cm depth) was done randomly in three selected spots with three repetitions in the north and south directions in the region. Finally, all the plant and soil samples were transferred to the medicinal plant laboratory and the soil science laboratory of Sari University of Agricultural Sciences and Natural Resources to perform the desired tests. The physical and chemical properties of the soil were measured based on existing recipes (Jafari haghighi, 2003). After cleaning, the plant samples were dried in the open air in the shade environment. 100 grams of each dried sample was extracted by clevenger machine in the central laboratory of Sari University of Agricultural Sciences and Natural Resources by distillation method with water for 3 hours and dehydrated by sodium sulfate anhydride and kept at 4 degrees until injection into chromatography devices. The resulting essential oil was obtained by injecting into a gas chromatograph connected to a mass spectrometer (GC/MS). Also, the percentage of essential compounds of each compound was calculated.

In order to analyze the quantitative and qualitative data of soil and essential oil, the normality of the data was first checked with the Kolmograph-Smirnov test. Then, the comparison of plant chemical compounds and soil quality indicators in the two northern and southern aspects was done using independent T-student test. Finally, Pearson's correlation analysis was used to analyze the relationships between plant chemical composition data, soil quality indicators and climatic data. All the above tests were performed by Spss software version 22.

Result and Discussion

The comparison of the essential oil yield in the northern and southern ranges also showed that the southern range has a higher average essential oil yield than the northern range. There is a significant difference between the two ranges at the five percent level. It seems that the reason for this is the increase in temperature and sunlight in the southern aspect, which has affected the yield of essential oil. On the other hand, in relation to the increase in the amount of essential oil in the southern aspect, it is possible that the plant produces essential oil protective compounds under heat stress. Benjemia et al., (2015) stated in their studies that dry conditions increase sesquiterpenes and decrease monoterpenes in essential oil compounds, which is consistent with the results of the present study. The results of the research by Aalipour et al. (2015) also indicated that the increase in light increases the amount of essential oil, which is in line with the results of the present study. also, in this regard, the research results of Bernath (2000) have shown that light and temperature in the southern aspects have a major effect on the quantity and quality of secondary metabolites of

medicinal plants, which is consistent with the results of the present study. The studies of Tavakoli et al., (2022) regarding the effect of environmental factors on the quantity and quality of essential oil indicated that rainfall causes an increase in secondary metabolites in the plant, which is contrary to the results of the present study. It seems that this discrepancy is because the habitat studied by these researchers was in dry areas. Dehghan et al., (2014) stated in their studies that in arid regions, with an increase in rainfall, the synthesis of secondary metabolites increases due to an increase in soil nutrients. In this study, the results of the comparison of the average compounds in the essential oil of the Stachys lavandulifolia plant in the northern and southern aspects indicated that the compounds Phytol, Hexadecanoic acid, Sabinene, γ-cadinene, α-fenchene, Thymol, 1-8-Cineole, cis -sabinene hydrate, Bicyclo[4.4.0]dec-1-ene, 2-isopropyl-5-methyl-9-methylene, Linalool, β-phellandrene, Stigmasterol, Myrcene, α.-Terpineol, Cis-farnesol, Caryophyllene, p -cymene, β-pinene, α-phellandrene, Heptacosane, Terpinene-4-acetate and Spathulenol have a significant difference at the 1 % level. Also, α-pinene, Limonene and Cyclofenchene compounds showed a significant difference at the five percent level. This is while the other available compounds did not show any significant difference. As the results show, in the findings of the studies of other researchers, the number of different compounds with different percentages have been stated for the *Stachys lavandulifolia* plant, which is different from the present study in terms of the number of compounds and their percentage. The reason for this is that the difference in the composition of the essential oil can be caused by the difference in the ecological characteristics of the growing areas such as temperature, rainfall and soil factors (Kazemizadeh et al., 2008). It has also been stated that the reduction of organic matter and the increase of soil pH according to the altitude and range cause a change in the amount and type of compounds received from the essential oil. In this regard, Saadatfar et al., (2020) and Rowshan and Kavoosi (2013) stated that the difference in the findings of others in terms of diversity in the number and amount of compounds can be caused by ecological differences in the place where the plant grows, including climatic, edaphic and genetic factors. the correlation results of soil and climatic factors with the percentage of essential oil compounds showed that the majority of essential oil compounds were not correlated with climatic factors (temperature and precipitation), which the above results are consistent with the studies of Jafarian et al., (2019) and Mohajan et al., (2020) and this indicates that that the amount of rainfall and temperature had little effect on the quality of *Stachys lavandulifolia* plant essential oil in this region. On the other hand, regarding the influence of climatic factors, Mehalaine and Chenchouni (2021) stated that among environmental factors, temperature has little effect on essential oil compounds.

Conclusions

The results of this research and the research of others (Saadatfar et al., 2020; Aghaie joubani, 2015; Yazdinezhad et al, 2015; Mirazadi et al., 2013) indicate that the growth and performance of plants

in ecosystems are influenced by various factors that All of them are divided into four groups of climatic, edaphic, topographic and biological factors and can have a great impact on the quantity, quality of the product and the amount of effective substances of plants.

Keywords: Climatic factors, Essential oil, Soil factors, Stachys lavandulifolia Vahl.