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The variability of component composition of *Nigella sativa L.* supercritical CO_2 extract depending on soil-climatic conditions

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ABSTRACT

A considerable body of works on black cumin (*Nigella sativa* L.) is encountered in the literature. But the data differ both on a quantitative yield of extractive substances and a component composition of extracts. The pharmaceutical and food industries have an incentive to obtain the extracts with predictable component composition. In this research we determine a change in component composition of plant extracts with soil-climatic environment.

INTRODUCTION

The discrepancies in analysis data of a component composition and in the quantitative yield of the supercritical CO_2 (SC CO_2) extracts from plant raw material, gathered under different soil-climatic conditions, are frequent in the literature [1-3]. For the purpose of elucidating this problem, we cultivated *N. sativa* in mountain experimental gardens at a height of 100, 1100, 1650, 1950 meters above sea level under similar treatment in Dagestan (Russia). For comparison, we got and researched a sample of *N. sativa* grown in Al-Kasim area of Saudi Arabia. A component composition of those was detected in GC-MS Shimadzu GCMS-QP2010 Plus.

MATERIALS AND METHODS

The gathered material was dried in the shade at 30ºC for 20 days up to 8% of moisture. The prepared material was grinded up to 0.3-0.5 mm. After that, the SC CO_2 extracts were obtained at the pressure of 30 MPa and the temperature of 40ºC. The extraction time was 2 hours with SC CO_2 flow rate of 1.5 kg/h. The given parameters provided a full extraction. The CO_2 technique was chosen as most optimal one allowing to extract a great number of groups of fat-soluble substances.

The compositional analysis of extracts was carried out using Shimadzu GCMS-QP2010plus chromatograph-mass spectrometer in Supelco SLB TM-5ms column (30 m×0.25 mm×0.25μm) in “split” mode. High-purity helium (99.9999%) with a flow rate of 1 mL/min was used as a carrier gas. The column temperature was raised from 60°C (the hold time was 4 min) to 150°C at a rate of 10°C/min after that up to 250°C at a rate of 5°C/min. The temperature of an injector, an interface, and a detector was 250°C. The ionization was performed by an electron impact with electron energy of 70 eV. The cathode emission current was 60μA, a range of recorded ions was 45–500 m/z. The identification of components was performed by means of NIST08 and FFNSC mass-spectra libraries. Before analysis, a test portion was diluted in n-hexane by a factor of 1000. 1 mL of diluted test portion was injected with split of 1:40 [4, 5].

RESULTS

The data on a total yield and the relative content of thymoquinone, ground substance for *N. Sativa*, in SC CO_2-extract are shown in Table 1. Thymoquinone is antitumor, antibacterial antioxidant of *N. sativa* oil [6]. The experimental measurements indicate that the higher a *N. sativa* cultivation region above sea level, the higher the content of lipophilic substances in it. The inverse dependence is observed in relative thymoquinone content.

Table 1. The yield and relative content of thymoquinone in *N. sativa* SC CO_2-extracts (P = 30 MPa, t = 40ºC) depending on a cultivation region.

Cultivation region	Height above sea level, m	Yield, (%)	Thymoquinone content, (%)
Dagestan, Russia	100	19.220	46.03
Al-Kasim (Saudi Arabia)	600	19.796	46.03
Dagestan, Russia	1100	21.778	45.53
Dagestan, Russia	1650	21.835	43.31
Dagestan, Russia	1950	17.017	32.83

The sample extracted from a plant material gathered at a height of 1950 meters above sea level is fall out of general regularity that evidently is the extreme condition for the plant.

Figure 1 depicts the dependence of a relative content of different substance classes in extracts on soil-climatic conditions. As is evident from the figure, the higher the height above sea level is, the lesser a relative content of acids and the higher a content of monoterpenes and sesquiterpenes are.

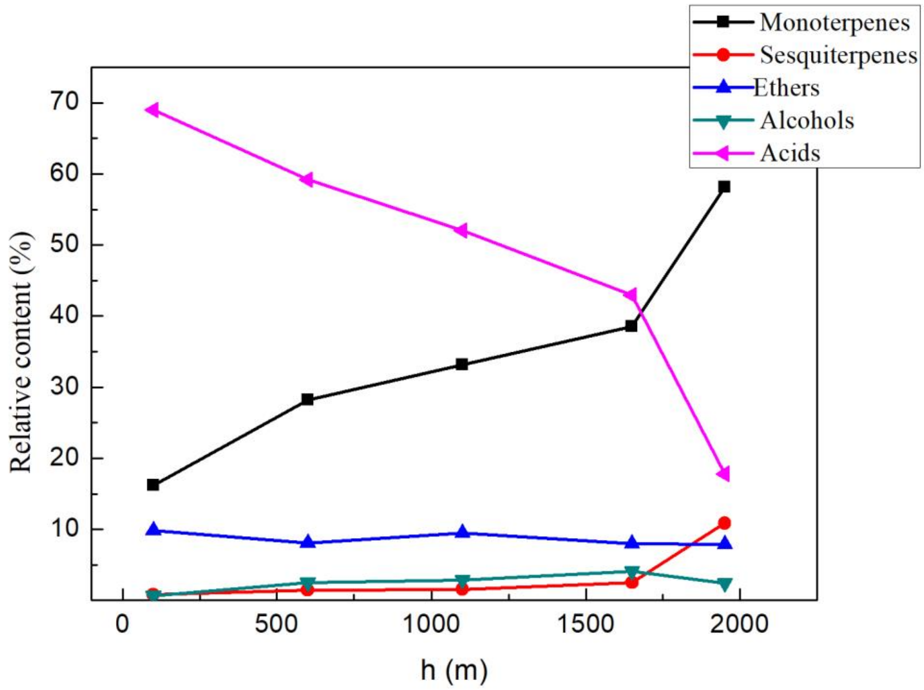

Fig.1 Relative content of different classes of compositions in *N. Sativa* in the dependence on soil-climatic conditions.

Probably, in the cold mountain regions, plants synthesize only minimum substances needed to maintain their species.

CONCLUSION

According to obtained data we can conclude that for receiving the predictable extracts it is important to know not only the parameters of extraction of biologically active substances but also the soil and climatic conditions of plant cultivation.

CO_2 technique allows the extraction of different groups of substances from the plant, which provides obtaining the extracts rich in composition and a successful application in fundamental researches in biology.

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