

TERPENES IN FOREST AIR – HEALTH BENEFIT AND HEALING POTENTIAL

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Abstract

Wellness function and potential of the forest cover a wide range of physical, chemical, biological and last but not least aesthetic stimuli. The forest has an important influence on air composition through its positive essential substances. Besides favourable contribution of light ions there are primarily balsamic substances (essential oils) there. It is a substance primarily based on terpenes. These are created mainly in coniferous forests, in compositions of spruce, fir, pine, bog pine, dwarf pine/scrub and dwarf pine Pinus rotundata bog. Shumava Mountain area in the Czech Republic presents an example of such "ecotype". In terms of the impact of such an environment on human are reminded that stay in forest is, from a health perspective, a case of natural inhalation. The artificial inhalations are for example humidifiers, nebulizers, aromatic lamps, candles, etc. The authors investigated the presence of balsam oil in forest air in Shumava locations of Brezník, Poledník and Modrava in the National Park Shumava. As a surrogate (broad indicator) was selected and determined the alpha-pinene. Balsamic essential oils have the effect of antimicrobial, antiseptic, bronchodilator, expectorant and anti-allergic. The results analyses of this survey, including a comparison of alpha pinene in the "healthy" forest and the "dead" forest (affected and destructed due to bark beetle calamity) declare the significant higher presence of balsam oils in the "healthy" forest than in the "dead" forest. It is possible to conclude, that in the healthy forest in Shumava, particularly in the areas of Poledník and Modrava, during a stay or move of human is realised the positive effect in terms of natural inhalation of balsam essential oils.

Keywords

Forest, terpenes, inhalations, alpha-pine, wellness

INTRODUCTION

Forest represents a landscape element, which has a complex and irreplaceable contribution to the environment formation. Under the

human influence the forest takes different functions as productive function, water management function, landscaping function and wellness as well (Gross, 2006; Flemming, 1995; Šišlák, 2014). From the view of

balneology forest represent an important element, especially in the case of "climate spa"(Jandová, 2009; Vyhláška MZ 423/2001, 2001; Law 164/1001, 2001; Trenčiansky, 2005). The same is valid from the view of other healing and wellness, activities (Ulbrichová, 2010; Schneider, 2008; Schneider, 2009; Flemming, 1995; Nebesař, 2013; Khallaf, 2011). Besides the effects on climate (creation and alternating of irritable and calming influence, effect on air flow and air temperature, humidity, purity, impact on solar radiation) has the forest one other very special influence. This influence is based on yield of light ions and emission of balsamic essential oils (Nebesař, 2013; Jandová, 2009; Schneider, 2008; Schneider, 2009). As an indicator, a surrogate for the presence of the essential oils in the air is used primarily α -pinene (Pokorný, 2009). Thus a stay in the forest represents in wellness and balneology term exposure to physical, biochemical and aesthetic benefits (Lišková, 2011). Physical and biochemical effects favourably combine especially when taking into account the fact that persons moving in the woods breathe the forest air. In this way they are exposed to the natural inhalation with potentially beneficial effect on human health.

Stay in the forest as an example of the natural inhalation

Inhalation means an incorporation of substances with positive effect into humans through breathing. Inhalations we divide in the artificial and the natural (Šťastný, 2013; Sedlářová, et

al., 2008). The natural inhalations are realized due a stay or a walk of exposure persons in the forests (Fleming,1995; Jandová, 2009; Nebesař, 2013; Schneider, 2008; Šťastný, 2013; Trenčiansky, 2005; Ulbrichová, 2010), where they create a part of climate spa procedures, or on the seashore (Bauer, 2013; Charlier, Chaineux, 2009), where they are a part of thalassotherapy. One of the major health substances, inspired into the human body during the natural inhalation of forest air, is the balm essential oil (Janda, 2009; Šťastný, 2013; Sedlářová, 2008). When considering this phenomenon, it is necessary to bear in mind that during quiet respiration a man exchanges about 10.5 m³ of air in his lungs in 24 hours. As to the chemical nature of the balsamic oils consist mainly of terpenes. Their prime example and a good indication of their presence is a monoterpene α -pinene.

Essential oils and their active substances in the context of beneficial effect on human health

The essential oils and the aromatic substances contained in the sap of plants are used by man since immemorial time for their sensory aromatic effects, disinfectants and preservatives. Their influence on microorganisms can be likened to the effects of disinfectants and antibiotics (Bacílková, 2012; Modr, Hejlek, 1974). Active ingredients of these oils are especially terpenes. They are present in relatively high concentration in the sap of conifers. A special place in this context has Shumava Mountins area,

where stands of spruce, fir, pine, pine-dwarf pine, *Pinus rotundata* bog bog and kneeling pose a huge reservoir and abundant source of these essential oils (Skuhrový, 2006). In the Czech Medical and Pharmaceutical environment is the significant oil, *Oleum Pini pumilionis* substance pharmacopoeia (Czech Pharmacopoeia, 2009; Modr, Hejlek, 1974). It is used as in drops and inhaled, such as cough medicine, as well as to facilitate expectoration, to dampen ineffective cough. Balsam essential oils from coniferous trees have the antimicrobial, antiseptic, bronchodilator, expectorant and anti-allergic effects. They are used in the treatment of diseases of the upper respiratory tract even in allergic conditions, both adults and children (Nebesař, 2014). Therefore balsam oils are used, especially for its terpene content, both in the form of artificial inhalation (Modr, Hejlek, 1974; Czech Pharmacopoeia, 2009) and in the form of natural inhalation (Janda, 2009; Nebesař, 2013; Nebesař, 2014; Sedlářová, 2008; Šťastný, 2013; Trenčiansky, 2005).

AIM OF THE STUDY, HYPOTHESES

The main aim of the presenter research study was to analyse presence of essential oils, specified as a monoterpene α -pinene, in the forest air of the locality Shumava Mountains. Hypothetically we presumed that the detected concentrations of α -pinen, when taken into account as the surrogate of total balsamic silices amount in the

processed air, could indicate the possible health-status-pertinent basis for natural inhalations in researched areas.

METHODS, PROCEDURE

Research procedure

In the National Park Shumava Mountains authors of the study, in cooperation with experts from the State Health Institute in Ostrava, investigated the concentration of the serum α pinene in the forest air. Research monitoring was provided in the three locations of the National Park Shumava Mountains - in the places Brezník, Poledník and Modrava, In every named place the forest air was monitored, always in pairs, it means in the "healthy" forest and the "dead" forest (affected and destructed due to bark beetle calamity). The identification of the localities for monitoring was carried out by personnel of the National Park Shumava Mountains. There were identified triple two sampling points there, e.g. six sampling sites altogether. The sampling was carried out synchronously over a period of two hours, since 12:30 to 2:30 p.m., on 06/07/2014, in the height of 160 cm above of the ground. The decided high was adequate to the probably height of human breathing space. Sampling was focused on the presence of α -pinene as a typical representative of terpenes present in the sap of conifers.

Diagnostic method and analyses

- *Sampling (qualitative and quantitative analyses):*

Set of the personal sample pumps SKC PCXR8 to the recommended flow rate with a sorbent tube TENAX TA in line. Air was collected by passing through the collection tube filled with Tenax TA, using the sampling pump. Captured terpenes were thermally desorbed in the laboratory and determined by gas chromatography with mass spectrometry (GC MS) in comparison with a library of spectra Wiley 275.

- *Analysing method:*
Gas chromatography Mass detection (Agilent 6890 N/ 5973 Network Selective Mass Detector) with thermal desorption (MARKES Unity Series 2) in line. Concentration α -Pinene is expressed in $\mu\text{g}/\text{m}^3$.
- *Monitoring, subscriptions:*
Monitoring, subscriptions and subsequent analyses were carried

out by the experts of the State Health Institute in Ostrava, in the workplace in town Jihlava.

RESULTS AND DISCUSSION

After the evaluation of obtained data from the collected sampling it was found out that the concentration of alpha pinene in the collected forest air in the places of the “dead” forest was analysed uniformly below $0.2 \mu\text{g}/\text{m}^3$. The positions, located in a living forest, alpha pinene concentration ranges from $0.2 \mu\text{g}/\text{m}^3$ in the Brezník place, over $0.32 \mu\text{g}/\text{m}^3$ in the Poledník place, to $0.45 \mu\text{g}/\text{m}^3$ in the Modrava place. The project protocol, including graphic documentation and detailed summary of climatic conditions was completed and archived.



Figure 1 Sampling place Brezník – Healthy forest (odběr na trubice s tenaxem TA)



Figure 2 Sampling place Breznik (Mokruvky) – Dead forest (sampling on tubes with Tenax TA)

Table 1 Differences in values of the α -Pinene Concentrations between Health forest and Dead forest in monitored localities Breznik, Polednik, Modrava

Locality	α -Pinene Concentration in Health Forest	α -Pinene Concentration in Dead Forest
Breznik	0.22 $\mu\text{g}/\text{m}^3$	<0,2 $\mu\text{g}/\text{m}^3$
Polednik	0.32 $\mu\text{g}/\text{m}^3$	<0,2 $\mu\text{g}/\text{m}^3$
Modrava	0.45 $\mu\text{g}/\text{m}^3$	<0,2 $\mu\text{g}/\text{m}^3$

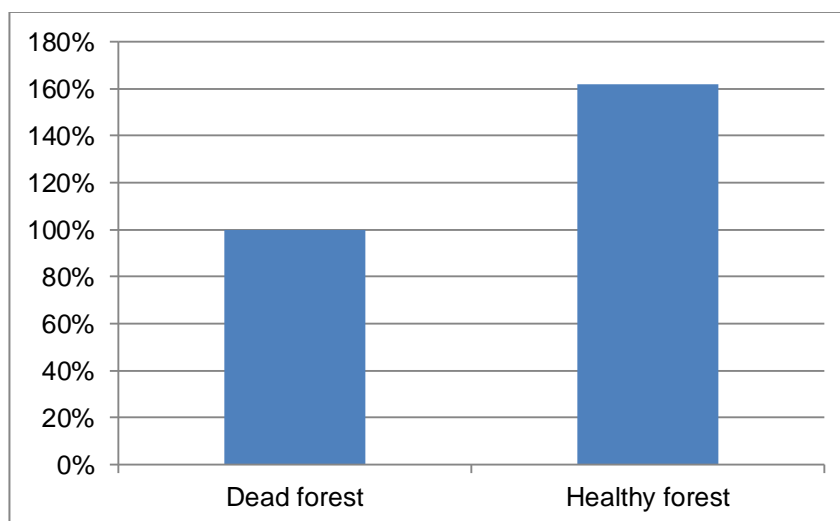


Figure 3 Differences between monitored Dead forests and Healthy forests from the view of the α -Pinene concentration level, expressed in percentage

When considering the potential positive impact of the balsamic essential oils, consisting mainly by terpenes in the inhaled air, it should be considered also possibly risks of the terpenes volume in the inhaled air, thus their potential adverse effect. Terpenes represent a risk for the jobs where people work with wood (Falk, 1990). Even in the area of industrial woodworking machines is increased the concentration of terpenes in the air (Pokorný, 2009). In the air of urban and suburban locations, including parklands the concentrations of alpha-pinene do not exceed the value of 0.31 $\mu\text{g}/\text{m}^3$ as an indicator of the concentration of terpenes (Pokorný, 2009).

These concentrations are given in terms of the pollution assessment in the order (of one to two decimal orders of magnitude) lower than the risk values. Therefore terpenes are not monitored as possible pollutant in the free air (Pokorný, 2009).

Another necessary discussion input is to consider the relevance of the content of balsamic essential oils in the inhaled air during the process of the so-called natural inhalation. This relevance is assumed and mentioned practically in the all reference sources that deal with climate generally and with natural inhalations particularly (Inhalation, 2014; Jandová, 2009; Nebesař, 2013; Nebesař, 2014; Schneider, 2008; Schneider, 2009; Sedlářová, 2008; Šťastný, 2013; Trenčiansky, 2005; Ulbrichová, 2010).

The decree of the Ministry of Health No. 423/2001 Coll., in § 14, No. 1, sub lit a) directly requires that “the

assessment of the positive bioclimatic impact on human health, it is necessary to assess the individual components of the bioclimatic including aerosols. But the actual quantification of relevant substances are, however, in our and in the international literature hardly traceable.

In our study found concentrations of alpha pinene in the forest air in Shumava Mountain (0.32 - 0.45 $\mu\text{g}/\text{m}^3$) are safe (on the order of 1 - 2 decimal orders of magnitude) below the concentrations of potentially inappropriate. Yet the found concentrations of alpha pinene are sufficiently high that, when by the presumed extracting of 60% (Falk, 1990) and by the predicted 24-hour ventilation 10.5 m^3 ensure the next effects: bronchodilators, expectorant, antitussive, antiseptic, antimicrobial and anti-allergic.

In the discussion it is necessary also to accept the need of evaluation and control of the natural inhalation as a regime precaution. Here we remind the tool EDUTOOL, designed to the results evaluation and to the duration of educational interventions (Janeckova, 2014).

A separate point in this discussion presents the fact that pharmacotherapy and balneotherapy cannot be viewed as alternative phenomena, but as the complementary phenomena and the mutually complementary phenomena. One of the major pharmaceutical companies, namely “KRKA dd. Novo Mesto, Slovenia” self invests, supports and operates in the important thalaso-therapy centre in Strunjan on

the Slovenia's Adriatic coast (Bauer, 2013).

CONCLUSIONS

Visiting and staying in the healthy South Bohemian Forest in the locality of the Shumava Mountain represents an example of the natural inhalation, when the beneficent ingredients are balsam oils. Even with the expected quiescent regime, including sleep can be estimated the amount of ventilated air about 10.5 m³ /24 hours in adult humans.

From the presented results follow that for example in Modrava location, where we find the concentration of alpha-pinene of 0.45 ug/m³ in the healthy forest, leads the 24 hours ventilation (quiescent regime, including sleep) to the daily intake of at least 4.5 micrograms of the alpha-pinene into the lungs of the exposed persons, with positive effects - bronchodilators, antitussive, disinfectants, antimicrobial and hypoallergenic. In the areas affected by bark beetle, where the forest is "dead", the concentrations of alpha-pinene were found less than 0.20 µg/m³.

In direct correlation to the content of alpha-pinene in the air of the monitored and analysed locations of the Shumava Mountain can be presumed and make use also its therapeutic significance in the form of climate therapy. The monitored and analysed locations in the set represent actually a large extensive climatic spa.

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