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Pigments in mint leaves and stems

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Abstract
Mint is the genus belonging to the Labiatae family and includes a huge diversity of varieties with different sensory properties. An important quality parameter is its colour, and the compounds responsible for it are pigments such as chlorophyll a and b, carotenoids etc. The aim of the current research was to determine the pigment content in the leaves and the stems of different mint varieties grown in Latvia. Mint of nine varieties (Mentha suaveolens 'Apple mint', Mentha suaveolens 'Variegata', Mentha spicata 'Morocco', Menstha piperita 'Swiss', Mentha piperita 'Granada', Mentha piperita f. citrate 'Grapefruit', Mentha piperita 'Chocolate', Mentha piperita 'Almira', Mentha piperita 'Bavarian') collected in Latvia was analysed.

Keywords: Mint varieties; chlorophyll a; chlorophyll b; colour

Introduction
The genus Mentha (Lamiaceae), which is commonly known as mint, has been recognized for its medicinal, therapeutic and aromatic properties since ancient times. There are approximately 25-30 species of Mentha. These plants are of great economic importance because the aerial parts of these plants are used in cooking and in the production of aromatic products, daily items and pharmaceuticals. Mentha species have antidiarrheal, antimicrobial, antioxidant and anti-inflammatory properties, in addition to their therapeutic potential in the cardiovascular field of medicine. Human cells are affected by the reactive oxygen species produced during metabolism under physiological conditions. Antioxidants neutralize the free radicals, which destroy lipids, proteins, and nucleic acids. Several human disorders such as atherosclerosis, arthritis, ischemia, gastritis, cancer and many tissue injuries, such as a central nervous system injury, result from the destructive action of free radicals. Non-enzymatic compounds, including ascorbic acid, tocopherol and-carotene, which inhibit the formation of free radicals, can also be used as antioxidants. Antioxidants, which possess the ability to prevent damage caused by free radical-induced oxidative stress, are critical for the survival of organisms. Plant metabolites, including carbohydrates, organic and amino acids, vitamins, hormones, flavonoids, phenols and glucosinolates, are fundamental for plant development, stretch adjustment and protection. Apart from the importance of these compounds for the plant itself, they determine the nutrition value, color, taste, smell, antioxidative, anticarcinogenic, antihypertensive, calming, antimicrobial, immunostimulating and cholesterol lowering properties of the various plant parts. A considerable amount of research has already gone into the identification, biochemical characterization,
Localization and health benefits of plant metabolites. Making use of the recent advances in metabolite profiling will increase our understanding of metabolic systems by recognizing the interrelationships between various metabolites. In rice, it was studied using metabolic profiling that the flavonoids had a positive correlation with carotenoids. Moreover, the carotenoids showed a positive correlation with glucosinolates in Chinese cabbage. However, there are few studies on the relationship between metabolites in Mentha species.

Review and Literature
Wittmann *et al*. (2001) [7] aim to demonstrate the effectiveness and the adaptive significance of stem-internal carbon re-fixation in a high light-preferring pioneer tree, Populus tremula, and a shade-preferring forest tree, Fagus sylvatica, that were grown under different light regimes.

Chlorophyll contents of young beech twigs were higher under low light conditions, and chlorophyll a/b ratios of the bark were similar to those of shade-adapted leaves. In addition, chlorophyll a/b ratios of the bark chlorenchyma were lower as compared to the leaves, possibly due to the shading effect of the outer cork layers which reduces light penetration. Within current-year branch of Populus tremula, the chlorophyll content of bark chlorenchyma was age-dependent. Peridermal light transmission was higher in current-year beech twigs than in one-year-old twigs, suggesting that using juvenile plants to study corticular photosynthesis is ideal

Chlorophyll content (a and b) tend to increase with decreasing light exposure in order to increase light harvesting in shade tolerant species (Valladares and Niinemetes, 2008) [2]. However, in the 8-week samples, the 100% light exposure treatment showed the highest total chlorophyll content, inconsistent with the aforementioned general trend. In contrast, in the 4-week samples, the 50% light exposure treatment showed the highest total chlorophyll content. It appeared that Fraxinus latifolia stems somewhat displayed shade-tolerant characteristic specifically in stems treated with partial sunlight exposure for only the 4-week time period. Applying shade cloth to the stems for a longer period of time (i.e 8 weeks) or completely blocking sunlight from the stems (i.e. 0% light exposure) did not yield the highest total chlorophyll content, thereby possibly indicating that prolonged low light condition and even no light exposure do not necessarily increase light harvesting in the shade tolerant Fraxinus latifolia seedlings

Striking differences were observed when comparing total chlorophyll content across different time periods. Noted that chlorophyll content of birch stems increased as early as March. Furthermore, reported a springtime increase in chlorophyll in aspen bark. Nevertheless, in the present study, the total chlorophyll content of the 0% and 100% light exposure treatments significantly decreased by 47% and 67%, respectively, from the 14 8-week time period to the 4-week time period (i.e. from December to March). The sharp decline in chlorophyll content observed indicates that chlorophyll content decreases from winter to spring in Fraxinus latifolia barks. Pearson and Lawrence (1958) noted that the chlorophyll content of aspen bark decreased over the period of May to August. Thus, chlorophyll content in barks is expected to decrease not only during spring, but potentially during the summer as well.

Conclusions

The content of pigments and the colour of analysed mint species differed significantly. The highest content of chlorophyll a, chlorophyll b and total chlorophyll in Mentha piperita 'Bavarian' mint leaves was observed, whereas Mentha spicata 'Morocco' has the highest content of carotenoids. There was not established correlation between the concentration of pigments and the parameters characterizing colour.

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