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“Phystech-Lyceum”

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“Start in innovation”

Research on the influence of light of different wavelengths on the production of essential oil of Ocimium basillicum

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Introduction

Essential oils are mixtures of fragrant substances produced by plants. The composition of essential oils is extensive. They are composed of hydrocarbons, alcohols, esters, ketones, aldehydes, lactones and other groups of organic compounds. Many of them have high biological activity and various pharmacological properties. Despite complexity of the composition and the multifunctionality of the action, essential oils are mainly used as flavoring agents for the taste and smell of medicines. In pharmacology, essential oils are used mainly as anti-inflammatory (25%), antibacterial (21%), analgesic (16%), antispasmodic (10%), local-irritating (8%) and, less often, sedatives (5%). Also, many constituents of essential oils are used in perfumery as components of compositions, odor fixers.

Basil is one of the essential oil crops that is widely used in the food, pharmaceutical and perfume industries. In folk medicine, basil is used as an expectorant, anti-inflammatory agent, gastritis, colitis, nephritis, etc. Numerous studies have found that basil essential oil has good antioxidant, antimicrobial and cytostatic activity. Basil essential oil is composed of camphor, beta-linalool, eugenol, germacrene D and phytol mainly.[1]

Camphor is used in medicine as an analeptic agent, for example, in acute and chronic heart failure, respiratory depression, pneumonia, poisoning with hypnotics and narcotic substances as an antidote.

Linalool is used to prepare linalyl acetate, an ester of linalool and acetic acid having a distinct lily of the valley odor. Both linalool and linalyl acetate are used in the perfumery industry for formulation, as well as in the manufacture of hygiene and cosmetic products.

Eugenol, as well as its derivative - isoeugenol, is used in the perfumery industry. Also eugenol is a part of analgesics, biocidal preparations and antiseptics. It is widely used in dentistry: a mixture of eugenol with zinc oxide, called zinc oxide-eugenol cement, is used as a material for temporary filling material, a material for insulating and medicinal pads.

Germacrene D is used in perfumery as a fragrance and is also a part of some anthelmintic drugs.

Phytol is used in the cosmetic industry; it stimulates the growth of lactic acid bacteria. Also used in the pharmaceutical industry in biochemical synthesis.

The processes occurring in a plant under the influence of light are influenced by its spectral composition and intensity. Changes in plant morphology under the influence of light radiation is called photomorphogenesis. After the seed germinates through the soil, the influence of light on the ontogenesis of the plant begins to affect. It is known that under the influence of red light, the process of seed germination is activated, the far-red light suppresses germination. For plants with small seeds, this is necessary because they do not have enough nutrients to germinate through a thick layer of soil, and, as a rule, an increase in the thickness of the soil layer increases the proportion of far-red light, and germination is suppressed to reduce competition between seeds. Plant species with large seeds and an adequate supply of nutrients do not require light to induce germination. In the absence of light, the sprout remains in the so-called etiolated state, while it has a pale appearance and a hooked shape. The hook is the outwardly emerging epicotyl or hypocotyl needed to protect the growing point as it germinates through the soil, and will persist if growth continues in the dark. The restructuring of processes in etiolated crops occurs under the influence of light. Plants are usually sensitive to blue, red, and far-red light wavelengths, and this or that photosensory system is activated. Photoreceptors sensitive to red and far red rays are

called phytochromes. There are also at least 5 types of photoreceptors that are sensitive to blue rays. Photoreceptor systems in plants are composed of phytochromes and blue-sensitive systems.

Phytochrome allows the plant to respond on impact to red and far-red rays. Phytochromes are protein compounds containing a pigment (chromophore) that acts as a prosthetic group. Phytochrome apoprotein is synthesized in the form of Fr (phytochrome red). In the process of attaching the chromophore, the holoprotein becomes sensitive to light. Under the influence of red light, it turns into a biologically active Ffr (far-red phytochrome) form. Ffr form under the influence of far-red light again goes into the Fr state. Molecular analysis of phytochrome and phytochrome-like genes in higher plants (ferns, mosses, algae) and photosynthetic bacteria showed that photochromes originated from photoreceptors of prokaryotes, plant precursors.

Plants have several photoreceptors that are sensitive to the rays of the blue part of the spectrum (b-photoreceptors), which perform very different functions than the photoreceptors in the red part of the spectrum. Based on the results of experiments on the study of the spectrum of action and molecular analysis, it was proved that higher plants have at least 4 different b-photoreceptors. The first b-receptors, the presence of which could be determined in many organisms, were cryptochromes. These proteins contain chromophores from the flavin group. Cryptochromes were allocated from microbial DNA photolyase, an enzyme intended to restore a DNA molecule damaged by ultraviolet radiation. Cryptochromes are also found in plants. They control the processes of stem elongation, leaf growth, circadian rhythms and flowering. In addition to blue light, cryptochromes also perceive near ultraviolet (UV-A) light.[2]

Also, all photoreceptor systems have a direct effect on the secretion of hormones that can change the composition of essential oils, which we are going to investigate.

Goal of the work

Explore the influence of red light on the production and composition of essential oils of vegetable basil varieties: “Aroma of cinnamon”, “Curly Khlopets”, “Gourmet Cloves”, “Caramel”, “Lime”, “Dwarf”; and also compare the efficiency of extraction using ethanol and methylene chloride.

Tasks

1. Grow basil varieties under standard and red light conditions from seeds.
2. Dry the biomass of the basil varieties, grind and make the samples of equal weight.
3. Carry out the extraction of the essential oil by insistence in 50% solutions of ethanol and methylene chloride.
4. Conduct gas chromatography of the obtained samples in order to obtain data on the qualitative and quantitative composition
5. Analyze the obtained data, draw conclusions about the effect of lighting, the composition of essential oils of cultivated varieties and the effectiveness of extraction methods.

Progress

Seeds of six varieties of basil: "Aromat koritsi", "Chlopec kucheryaviy", "Gurman gvozdichniy", "Caramel", "Lime", "Karlik" were sown in prepared soil in identical cells and grown in the laboratory of the ANEO «Phystech-Lyceum» named after P.L. Kapitsa under the light for 12 hours. The following varieties were grown under normal white light: “Gourmet Clove”, “Caramel”, “Aroma of cinnamon” and “Karlik”. The following varieties were grown under red light: "Gourmet Clove", "Caramel", "Lime", "Curly Khlopets". All varieties were grown at the

same conditions, with the exception of light from sowing on September 30, 2020 to harvest for drying on December 4, 2020.

Also for comparison of efficiency of methods of extraction with solutions of ethanol and dichloromethane Experimatal Station TRFA provided containers with biomass of basil varieties “Ararat” and “Karlik” that were planted on 03.10.2020. The provided biomass was grinded and put partially into 50% ethanol solution and 50% dichloromethane solution. Dichloromethane in high concentration was got from the lab solution via multiple distillation and drainage with phosphorus pentoxide. After the preparation of solutions of extractants, they were mixed up with the grinded basil biomass as an aliquot with mass 1,5 gram in mass ratio 1:20. Insistence was performed for 15 days for provided varieties.

Similar actions were held with the varieties grown in the laboratory of ANEO “Fiztekh-Litsey”. In the experiment with varieties grown in different light the factor of efficiency of method of extraction wasn’t investigated, so the 50% solution of ethanol was used as an extractant. Every sample after the desiccation was grinded and mixed with the solution of ethanol with mass ratio 1:20. Insistence was performed for 50 days.

All the samples were brought to the same mass after the extraction

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[1] (Sevruk IA, Pisarev DI, Novikov OO, et al. Investigation of ocimum basilicum l. Essential oil composition of the flora of Belgorod region. Research Result. Medicine and Pharmacy Series. 2015; 1 (3): 97-103)

[2] https://en.wikipedia.org/wiki/Photomorphogenesis