

## Study of Sage (*Salvia officinalis* L.) Cultivation in Condition of Using Irrigated Water Polluted By Cadmium and Lead

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**Introduction:** Accumulation of heavy metals in agronomic soils continuously by contaminated waste waters not only causes to contamination of soils but also it affects food quality and security. Cadmium and lead are one of the most important heavy metals due to long permanence and persistence in soil can cause problems to human and animal health. Some medicinal plants are able to accumulate of heavy metals from contaminated soils. Heavy metals are not able to enter in the essential oil of some aromatic plants. Study of these plants helps human to select them for cultivating the resistant medicinal plants in contaminated soils.

**Materials and Methods:** This experiment was carried out in the research greenhouse of agriculture faculty of Ferdowsi university of Mashhad in 2011. Seeds were cultivated in planting aprons into peat moss medium. Then the uniform plantlets were transferred into soil in the plastic boxes (30×50×35 cm) at two leaf stage. In each box 6 plantlets were sown with distance of 15 cm on the planting rows and 20 cm between rows. Experiment was set up as factorial on the basis of randomized complete block design with three replications. The first factor was cadmium concentrations consisted of 0,10,20,40 mg per kilogram and the second factor was lead concentrations consisted of 0,100,300 and 600 mg/kg. Plants were irrigated during of 15 weeks with cadmium and lead nitrogen nitrate solutions and then irrigated with distilled water. The differences of nitrogen amounts in treatments were compensated with ammonium nitrate on the basis of differences between level of the highest treatment and the treatment which obtained lower amount of nitrogen. Plants were harvested after 180 days at the beginning of flowering. All shoots and roots were weighted separately as fresh weight and then were dried under shading and then were weighted. The essential oil sage was determined by using of 30 grams of dried sage leaves with distillation method with Clevenger. Cadmium and lead contents in shoot and root were measured by wet digestion method (digestion by Perchloric and Nitric acid). Cadmium and lead contents were detected by atomic absorption apparatus. Data were analyzed by MSTATC software and all means were compared by DMRT at 5% of probability.

**Result and Discussion:** Results argued that fresh weight of sage at 40 mg/kg of cadmium were decreased 4.61% as compare as control. Dry weight of sage decreased at 600 mg/kg of lead 11.08 % as compare of control. Mean comparisons indicated that at the highest concentrations of cadmium and lead fresh and dry weight of sage were dropped. Growth decrement due to toxicity of cadmium causes to photosynthesis and respiration decline, carbohydrate metabolism decreasing and leaf chlorosis. Researchers observed lead ions by interfering with water balance lead to water stress. High concentrations of lead may cause to decrease the availability of water for plant and high concentrations of cadmium causes to disturb the protein synthesis and lead to protein decline in plant cells. Plant height of sage was declined at 40 mg/kg and 600 mg/kg as compared as control 14.17 and 10.83, respectively. Essential oil in sage was dropped in high levels of cadmium and lead as compare of control 12 and 14.51, respectively. Researchers stated that cadmium concentrations of 2,6 and 10 mg/lit and 50,100 and 500 mg/kg of lead had no significant effect on peppermint, but caused to drop the essential oil percentage of dill and basil.

Disturbance of carbon nutrition in plant cells during the photosynthesis process by heavy metals lead to a decrease in the essential content. The most cadmium absorption by sage shoots belonged to 40 mg/kg and 600 mg/kg of cadmium and lead, respectively and then 40 mg/kg cadmium and 300 mg/kg lead were ranked as second treatment. Increase of cadmium and lead concentrations in irrigation water led to increase of these heavy metals into sage shoots. Increase of lead and cadmium concentrations caused to antagonistic effects of cadmium and lead absorption into shoots of sage. In this experiment cadmium and lead concentrations of all treatments

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were too below to detect by atomic absorption apparatus. In this study cadmium and lead could not enter to essential oil. Researchers stated that high doses of cadmium, lead, zinc and copper concentrations could not enter into essential oil in sage. Some researchers showed that cadmium, lead and copper were not transferred to essential oil of peppermint, dill and basil during the essential oil distillation process. This finding confirmed that selection of medicinal plants as alternative plants with crops in cadmium and lead contaminated soils.

**Conclusion:** Fresh and dry weight of Sage in the condition of contaminated soil by 100 mg/kg cadmium and 600 mg/kg lead were declined 4.61 and 5.16 % as compare as control, respectively. At the highest doses of cadmium and lead the essential oil of sage were dropped but, these heavy metals were not detected in essential oil. So, it is seems that this medicinal plant may be applied in the contaminated soil or in the condition of using of contaminated irrigated water by cadmium and lead.

**Keywords:** Medicinal plant, Heavy metals uptake, Morphological traits, Essential oil content