# Chlorophyll contents and their relationships with nutrients and $\delta^{13}C$

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## Introduction

Climate change in the Mediterranean Basin is expected to increase water scarcity, droughts, and evapotranspiration rates in summer, stressing plant species and altering photosynthesis, forest structure, and species distribution. In this changing environment, studying the ecophysiological characteristics of isolated populations like *J. drupacea*. is crucial to identify potential drought or nutrient deficiency effects and implement timely conservation measures.

The study of photosynthetic pigments, such as chlorophyll a (Chl a), chlorophyll b (Chl b) and carotenoids (Car), and their relation to foliar nutrients provide us important information of trees photosynthetic capacity, while stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) reveal plant physiology and ecological adaptations, since foliar $\delta^{13}C$ indicates water availability and $\delta^{15}N$ shows nitrogen sources and uptake.

## Study area

The study focused on six natural *J. drupacea* stands, where juniper trees represent the predominant species. These stands were selected to cover different microclimatic conditions within the *J. drupacea* distribution range on the Parnonas mountain, southeastern Peloponnesian Peninsula. In Europe *J. drupacea* is classified as Endangered and it is native to Southeast Turkey, Western Syria, Israel, Lebanon, and Southern Greece, where it's limited to the southeastern Peloponnese region.

## Materials and methods

At each study stand, one soil sample was collected, and current year needles were sampled from the sun-exposed canopy facing the southern aspect, of five *J. drupacea* trees.

**Soil samples**, were pulverized for C and $CaCO_3$ analysis. Soil pH was measured by a glass electrode, conductivity with a conductivity meter, organic C with the potassium dichromate method ($K_2Cr_2O_7$) (Benton Jones 2001), soil texture with the hydrometer method and the percentage of $CaCO_3$ with a calcimeter.

**Tree needles** were used for nutrient chemical analysis, chlorophyll and carotenoid contents and stable isotope composition of carbon and nitrogen.

## Results

### Soil samples

The majority of the soils in the area are alkaline and clay loams in terms of texture. The organic C content is considered rather high (ranged between 2.8 and 12 %). The percentage of $CaCO_3$ varied (0.4-21%) a great deal. The conductivity of the soil solution was not as high as to cause concern with regard to salinity.

### Foliar samples

Table 1. Pearson correlation coefficients among several plant properties and plant nutrients

| | Chl a | Chl b | Chl tot | Car | Chl a/b | Car/Chl tot | $\delta^{15}N$ | $\delta^{13}C$ |
|---|---|---|---|---|---|---|---|---|
| **Ca** | 0.131 | 0.231 | 0.163 | 0.232 | -0.307 | -0.308 | -0.066 | -0.478** |
| **Mg** | 0.065 | 0.189 | 0.103 | 0.123 | -0.389* | -0.381* | 0.158 | -0.284 |
| **K** | -0.89 | -0.111 | -0.099 | -0.128 | 0.073 | 0.079 | 0.416* | 0.205 |
| **N** | 0.353* | 0.283 | 0.339 | 0.300 | 0.160 | 0.146 | 0.163 | -0.118 |
| **P** | -0.069 | -0.062 | -0.072 | -0.085 | -0.014 | -0.004 | 0.547** | 0.208 |
| **Cu** | -0.76 | -0.156 | -0.103 | -0.145 | 0.245 | 0.252 | 0.212 | 0.383* |
| **Zn** | -0.174 | -0.27 | -0.206 | -0.292 | 0.272 | 0.278 | -0.098 | 0.328 |
| **Mn** | -0.324 | -0,358* | -0,340 | -0,267 | 0,088 | 0.082 | 0.140 | 0.358* |
| **Fe** | 0.371* | 0.417* | 0.393* | 0.450* | -0.191 | -0.193 | 0.310 | -0.476** |
| **Co** | -0.178 | -0.289 | -0.212 | -0.180 | 0.284 | 0.280 | -0.003 | 0.339 |
| **Ni** | 0.287 | 0.381* | 0.317 | 0.332 | -0.323 | -0.323 | 0.086 | -0.498** |
| **Ti** | 0.07 | 0.084 | 0.079 | 0.190 | -0.114 | -0.110 | -0.399* | -0.156 |
| **Mo** | 0.088 | 0.137 | 0.104 | 0.059 | -0.161 | -0.155 | -0.152 | 0.014 |

Additionally, the $\delta^{13}C$ correlated significantly and negatively with all the Chls and Car concentrations.

## Concluding remarks

The Syrian juniper is an oligotrophic evergreen species capable of thriving in rocky soils, as evidenced by the low concentrations of N and P in plant tissues. The positive correlation between Chl a and N is expected since N is a significant component of Chl molecules.

The negative correlation between Mg and the ratios of Chl a/b and $Car_{tot}/Chl_{tot}$ suggests that the trees may have produced more metabolites under these conditions. The significant correlation of Fe with both Chls and total Car underscores the crucial role of Fe in chlorophyll synthesis.

Additionally, the $\delta^{13}C$ values were significantly and negatively correlated with all Chl and Car concentrations, indicating that high $\delta^{13}C$ (a marker of drought stress) can negatively affect chlorophyll content and, consequently, the rate of photosynthesis.

## References

Benton Jones J.Jr., 2001. Laboratory guide for conducting soil tests and plant analysis. CRC Press, London. 363 p.

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