

Original Research Article

Dynamics of change of chlorophyll and carotenoid pigments in leaves of *Chrozophora tinctoria* species spread in Nakhchivan Autonomous Republic (Azerbaijan Republic)

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ABSTRACT

Background: The pigment composition and the dynamics of pigment accumulation were investigated to determine the degree of adaptation of *Chrozophora tinctoria* to the environmental conditions in the Nakhchivan Autonomous Republic (AR) of Azerbaijan Republic.

Methods: The leaves were collected (transects size 5×5 m, in triplicate) and dried with 15-20 pieces, pigments were separated by solvent. The pigment density was determined by the absorption peak on a spectrophotometer, and then the pigment density was calculated.

Results: The chlorophyll pigments in the dry weight of leaves varied between 2-6 mg and carotenoids 0.8-1.2 mg/g were found. Also, chlorophyll (a-b) pigments increased in 1.2 times, and carotenoids decreased in 3.6 times depending on environmental conditions.

Conclusions: Photosynthetic apparatus of the species actives in all cenosis with response adaptive to changing of environmental conditions depends from the time of leaf collection for the *Chrozophora tinctoria* species as shown results of researches.

Keywords: *Chrozophora tinctoria*, Chlorophyll and carotenoid pigments, Accumulation level of pigments

INTRODUCTION

Studying the plants adaptation to changing of environmental conditions within the biodiversity conservation program has been especially importance for the last century. The adaptive reaction of plants to the environment is also reflected in their physiology.^{1,2} As known the activity of pigment in plants varies not only by plant structure, but also by climatic conditions and, most importantly, by the degree of solar radiation insolation.³ Thus, high levels of insolation usually result of low levels of chlorophyll in the plant, indicating the plant's reliability and adaptation to environmental conditions.^{4,5} Chlorophyll is usually higher in shade-loving plants than in photophilous. The amount of carotenoids is usually increased under high insolation conditions.⁶ So,

insolation levels are not the same everywhere, and spectral distribution of solar radiation occurs. This also affects on the composition of photosynthetic pigments. The study of the amount of these pigments, their relative variability analysis are key indicators of the degree of plants adaptation to changing environmental conditions, as well as the ability of the photosynthetic apparatus. The purpose of our research was to investigate the dynamics of pigment composition changes in leaves of the *Chrozophora tinctoria* species grows in different environmental conditions.

METHODS

The study was carried out in 2017-18 in mountainous, lowland and lowland areas, differing by vegetation

abundance and environmental conditions (Julfa, Kangarli, Babek, Shahbuz districts) of the Nakhchivan Autonomous Republic. The size of the transects were 5x5 m, in triplicate. During the vegetative season, the leaves were collected and dried with 15-20 pieces, and pigments were separated by 80% acetone solution under laboratory conditions.^{7,8}

The pigment density was determined by the absorption peak on a spectrophotometer (Hitachi U-2900, UV-VIS), and then the pigment density was calculated by the Wettstein formula.⁹⁻¹² The amount of pigments has been calculated based by single mass of dry leaves.

RESULTS

Dyer’s Litmus, (Turnsole or Croton) - *Chrozophora tinctoria* (L.) Adr. Juss. species is common in the phytocenosis of the mountainous zone, lowland and dry rock slopes of plains of Nakhchivan AR. Association and microgroups have been found in saline semi-deserts vegetation near Nahajir-Gynyuk villages in the Julfa, in cereal- motley grass near Givrag village of Kangarli districts, in mountainous-xerophyte vegetation near Kolani-Bichenek village of Shakhbuz districts, in mix phytocenosis of Boyukduz plain of Babek districts of Nakhchivan AR. The pigment composition and the level of the pigments accumulation and the intensity of the photosynthetic apparatus were studied for determine the degree of adaptation of the plant to the environmental conditions in 4 regions.

The absorption centers of the pigments chlorophyll pigments in 420-660 nm wavelengths (Figure 1) and carotenoid pigments in 400-500 nm wavelengths (Figure 2) have been studied on the basis of spectras of acetone extracts of the species samples on spectrophotometr.

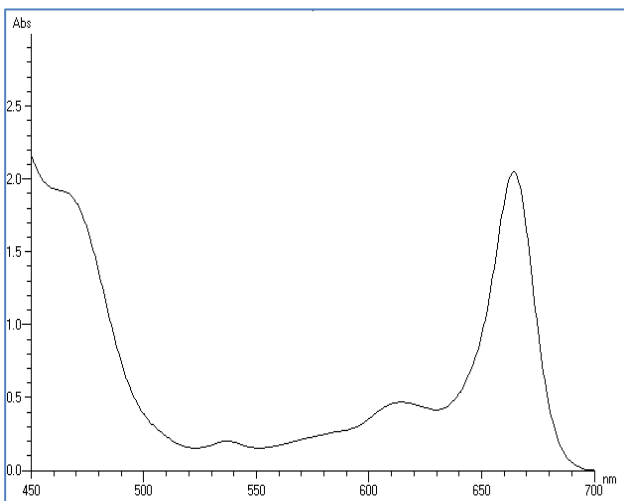


Figure 1: Absorption spectrum of chlorophyll pigment of *Chrozophora tinctoria* species.

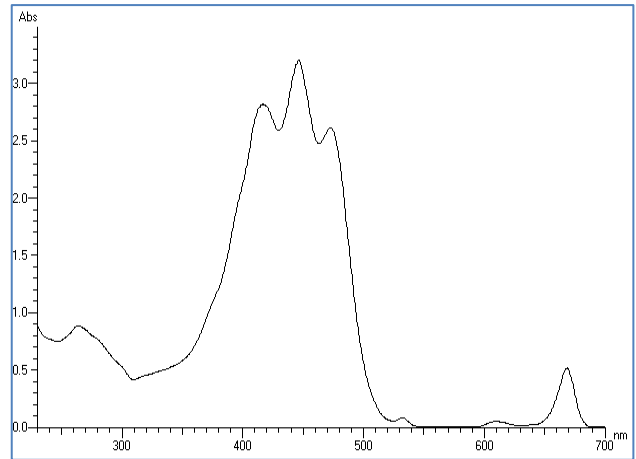


Figure 2: Absorption spectrum of carotene pigment of *Chrozophora tinctoria* species.

The chlorophyll-pigment content in the leaves of the *Chrozophora tinctoria* species is highest in the Shahbuz districts (4.31-4.14 mg/g for dry weight), with the least amount in the Julfa district (2.23-2.54 mg/g for dry weight) as shows results of the analysis. The highest amount of carotenoid pigments were determined every two years in samples collected from Julfa and Babek districts (1.42-1.63 mg/g; 1.65-1.59 mg/g for dry weight). Since leaf samples were taken during the vegetation period, there was a decrease in the accumulation levels of chlorophyll b pigment relative to the chlorophyll-a pigment (Figure 3 and 4).

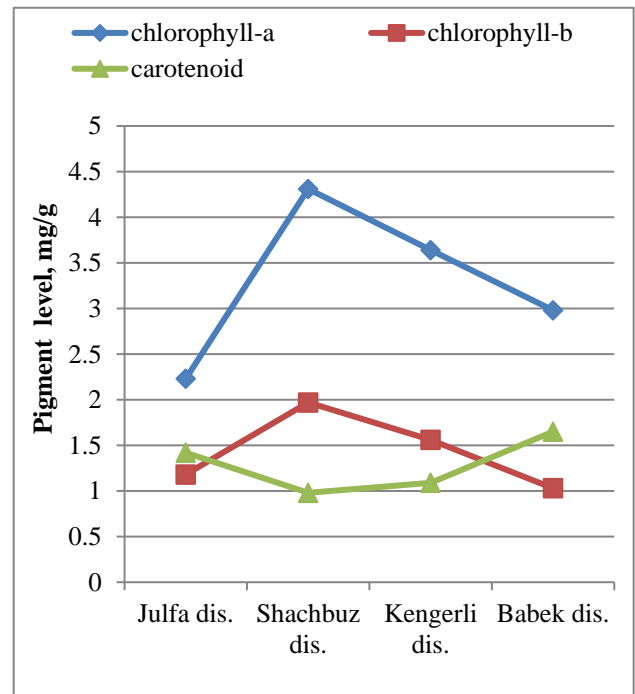


Figure 3: Accumulation level of pigments in leaves of *Chrozophora tinctoria* species (in 2017).

Table 1: Average annual amount of chlorophyll and carotenoid pigments in leaves of *Chrozophora tinctoria* (mg/g per dry weight).

S. no.	Regions	Chl.- a	Chl.-b	Carotenoid	Total amount of pigments	chl.a/chl.b	chl.a+chl.b/carotenoid
1	Julfa d.	2,39±0,07	0,87±0,04	1,53±0,03	4,52±0,08	2,73	2,13
2	Shachbuz d.	4,23±0,05	1,82±0,02	1,05±0,01	7,1±0,04	2,32	5,76
3	Kengerli d.	3,38±0,03	1,33±0,08	1,20±0,04	5,91±0,09	2,54	3,92
4	Babek d.	2,83±0,08	1,01±0,03	1,62±0,03	5,46±0,06	2,80	2,37

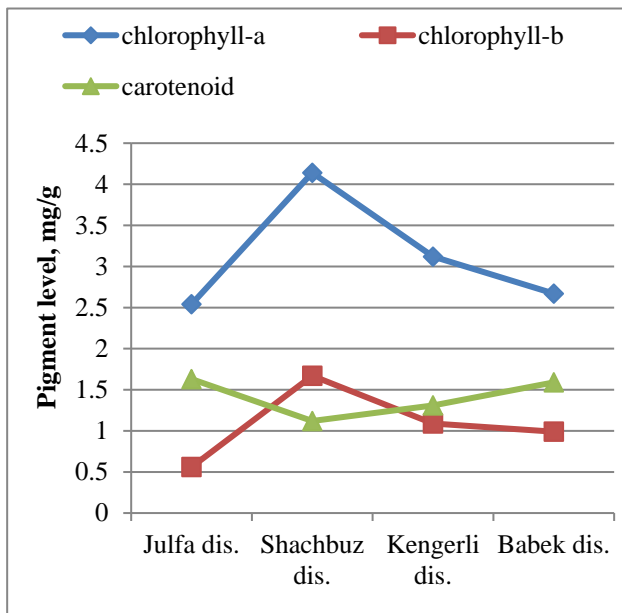


Figure 4: Accumulation level of pigments in leaves of *Chrozophora tinctoria* species (in 2018).

The amount of chlorophyll-a, which acts as the main pigment in the process of photosynthesis, is an indication of the activity level of this process. This ratio varied between 2.32 and 2.80 during the vegetation period when the samples were collected (Table 1). This also shows that the intensity of the photosynthetic apparatus is almost constant. The ratio of chlorophyll pigments to carotenoids 5.76 indicates that the activity of the photosynthetic apparatus in the Shachbuz districts is more intense.

DISCUSSION

Pigments play important role in the transformation of solar energy into chemical energy in plant photosynthetic cells. The pigment composition and the levels of the accumulation of pigments were studied for determine the degree of adaptation of the *Chrozophora tinctoria* to the environmental conditions and the intensity of the photosynthetic apparatus.

Chlorophyll is the main pigment involved in the process of photosynthesis, while carotenoids provide extra energy to the chlorophyll and also protect the plant's against susceptibility to light.^{13,14}

The decreasing accumulation levels of chlorophyll-b pigment relative to the chlorophyll-a pigment was observed in the researches. This is also an adaptive reaction of the plant to the environment.^{1,3} Thus, in the open cenos where excessive sunlight is exposed, the amount of carotenoids to protect against insolation increased compared to the chlorophyll pigment. The amount of chlorophyll pigments is increased to absorb more sunlight and regulate the process of photosynthesis in the forest and surrounding forests where grass cover is more abundant.¹⁵ It should be noted that the Shachbuz districts is a mountainous area and is distinguished from the others by the abundance of vegetation of cenosis. The grass cover of the cenosis is sparse and dry in the Babek and Julfa districts.

The ratio of chlorophyll-a pigment to chlorophyll-b pigment (chl.a/chl.b) and chlorophyll pigments to carotenoids are one of the main indicators of the ability of plant photosynthetic apparatus.^{16,17} The ratio of chl.a+chl.b/carotenoid indicates that the activity of the photosynthetic apparatus in the Shachbuz districts is more intense, in the Julfa and Shachbuz districts are low.

CONCLUSION

The pigment content of the species varies between 4.73-7.26 mg/g for dry weight has been found. Thus, the change in the ratio of chlorophyll pigments between 2.32 and 2.80 - indicates of the stable activity of the photosynthesis process, and the increase in the number of carotenoid pigments under high insolation conditions from 0.15 to 0.57 are indicates for the protection and adaptation of these pigments in the photosynthetic process. In general, the change in carotenoid and chlorophyll levels in plants should be regarded as a reaction and response of the pigment apparatus of the plant to the environment.

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