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**EVALUATION OF INTERNAL WATER AND PHYSIOLOGICAL INDICES OF  
ARTICHOKE PLANTS UNDER DROUGHT STRESS**

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**ABSTRACT**

Drought is one of the major constraints in crop production. The morphological and physiological understanding of drought resistance in improving stress under drought conditions is of great importance. To investigate the effect of drought stress effect on indicators to assess internal water and the physiological indicators of herbal plants of artichoke (*Cynara scolymus* L.), an experiment was conducted at the Institute of Agriculture and Natural Resources. The experiment treatments consisted of water discharged after evacuation of 20, 50 and 80% soil moisture as three levels of stress were considered. Metrics such as available water plant, leaf weight ratio, leaf area ratio and the amount of water lost per unit of leaf area were measured. There was no significant effect of physiological indices. Effect of drought stress on leaf water content RWC, specific leaf area SLA, SLW and specific leaf weight of water per unit leaf area LWCA was not significant. Highest RWC was seen in 50% water treatment and the lowest was of 80 % draught treatment. Most of the SLA was observed in 20% draught treatment and the lowest was in 50% draught treatment. SLW increased with tensions increasing compared to 20% draught treatment.

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Highest LWCA in 80% draught treatment and the lowest at 20% draught treatment was reported. Chlorophylls, carotenoids and anthocyanin in applied stresses were significant. An increase in stress leads to reduction in chlorophyll a, also at the same time chlorophyll b increased and total chlorophyll decreased. Meanwhile, the carotenoid and anthocyanin were significantly reduced by increasing the tensions from the average stress level (50% water) to severe water stress (80% water).

**Keywords: Water lost per unit leaf area, Carotenoids, specific leaf area index, Physiological indicators, Artichoke**

## INTRODUCTION

Water is a scarce resource in the country that is influenced by rainfall. Effect of Water Stress depends on time, durability and the size of the deficit. Identification of critical time and classification based on a precise program and essential for plant, is the key to maintaining water and improving irrigation and plant tolerance to water deficit in agriculture. Water is one of the most important environmental factors that has great influence on growth and active ingredients of medicinal plants. Water shortages during plants production can import heavy damages to growth and also ingredients from medicinal plants (Amydbygy, 2000).

Artichokes with scientific name (*Cynara scolymus* L.) from the Asteraceae plants (Compositae) (Mozaffarian, 1996) is a perennial herbaceous, sensitive to cold, with average life span of 4 years, which reaches a height of 2 meters.

Origin of the plant in southern Europe, the Mediterranean, North Africa and the Canary Islands. Usable parts of the Artichoke are shoots and roots (ZIAI *et al.*, 2004). Traditionally this herb works is beneficial to improve conditions such as diabetes, obesity, asthma, kidney stones, arteriosclerosis, rheumatism and skin diseases such as eczema, inflammation (Zargari, 2009). In another phenolic compounds in artichoke leaf extract were examined and observed antimicrobial activity of the plant (Zhu *et al.*, 2004).

Generally water stress by reducing the leaf area, stomatal closure, reduction in stomatal conductivity, reducing the intake of chloroplasts and other parts of the protoplasm, the reduction of photosynthesis and chlorophyll that causes protein synthesis reduction, reduction of Tvrzhsans and cell growth, the reduction of light absorbance and total capacity of plant photosynthesis particularly in leaves and stem of the plant,

the delay in germination (Hasani , 2006) and the subsequent reduction in yield and plant biomass occurs (Akbarinia *et al.*, 2005) .

Effect of drought stress on plants can be divided into two components stomatal and non- stomatal . Non- stomatal phenomenon caused by drought stress on physiological attributes such as LAI , LAD , specific leaf weight and water use efficiency and resources (Hekmat Shoar , 1372) . Research on the herb lemon balm and rosemary by Monet *et al* (1999) was conducted and concluded that the relative water stress reduces the rosemary water 40 % and lemon balm to 30 % . Safi Khani (2006 ) in their research on the treatment of 100 , 60 and 40 % of farm capacity of field on Moldavian balm concluded that the maximum amount of oil , soluble sugar and chlorophyll a and total treatments, respectively related to 40 , 60 and 100 % of farm capacity of field and with the increasing of stress the chlorophyll a reduced and chlorophyll b increased. They also by studying the growth parameters showed significant differences in WSD, RWC and non-significant differences in water availability per unit leaf area (LWCA) and specific leaf area (SLA) between the figures.

#### **MATERIALS AND METHODS**

The test in 2013 was performed at the research station martyr Fozoh Najaf Abad

dependent to Research Center and Natural Resources of Isfahan province with longitude 26 degrees and 51 minutes and 36 degrees 33 minutes latitude and the height of 1612 meters above sea level. According to the coupon classification the test area has Bwhs climate. The average rainfall is 125 mm and soil class of the station 2 and soil texture is clay. The minimum temperature is 14 ° C and max is 35 ° C. Test in a randomized complete block design with three replications was conducted. Each experimental unit consisted of 30 to 60 cm and 9 planted line. Ridges distance from each other is 60 cm, the distance of bush in each line is 30 cm and the plant harvesting in March of last year (2012) had been done as a pile of seeds planted on ridges. Weed control as hand weeding and insecticides was used for pest control in two stages ( Diazinon 2 per thousand ). The experiment treatments consisted of water stress at 3 levels: 20, 50, and 80 percent moisture content of 0-30 and 30-60 cm of soil depth in growing step. To control the soil moisture from depths of 0-30 and 30-60 cm, soil samples were taken and transferred to an oven at 100 ° C. After determining the moisture content of the soil at field capacity moisture content of the soil in order to apply the stress has been recognized. Relative water content using the formula ( Levitt , 1980) was measured as follows

$$RWC = \frac{wf - wd}{wt - wd}$$

Plant tissue wet weight = Wf

Swelling weight of the plant = Wt

Dry weight of the plant = Wd

The plant pigments measurement was performed in vegetative phase method ( Arnon , 1949) using relevant formulas .

$$chla (Mg / L) = (12 / 25 \times a663) - (2 / 79 \times a647)$$

$$chlb (Mg / L) = (21 / 5 \times a647) - (5 / 1 \times a663)$$

$$chla + b (Mg / L) = (7 / 15 \times a663) - (1871 \times a647)$$

The Chl a + b, Chl b, Chl , are respectively a content of chlorophyll a and b, and the sum a + b in terms of milligrams per liter of wet weight, and a is absorbance by extracts in related wavelengths. Specific leaf area

$$SLA = \frac{LA}{LDW}, \quad \text{specific leaf weight}$$

$$SLW = \frac{LDW}{LA}, \quad \text{the amount of water per unit}$$

$$\text{leaf area } LWCA = \frac{W1 - W2}{LA}, \quad \text{at the relations}$$

LA as leaf area, LDW leaf dry weight , TDW total dry weight , W1 leaves weight , W2 is the weight of the dried leaves .

## RESULTS AND DISCUSSION

According to the analysis of variance in the vegetative traits measured features were not significant in any of the treatments (**Table 1**). There were also no significant differences in

the average comparison **Table 2**. Effect of drought stress on leaf water content was not significant. The highest rate in the 50% draught treatment group and the lowest was at 80 %. Greater relative content of leaf water means the ability of leaf to keep more water in tension. Also the relative water content is a measure for the identification of resistant and susceptible cultivars (Haidari Sharif Abad, 2000). High relative water content reflects the high resistance of plants to drought stress, in a study that Mohammad Nasri and colleagues (2003) conducted on canola results showed the high correlation between the relative water content and water resistance.

Effect of drought stress on specific leaf area SLA was not significant. Most of the SLA in the treatment group (20%) and the lowest was seen in 50% draught treatment. Leaves under stress due to a decrease in cell size is reduced, which reduces SLA Sarkel (1993 ) reported high levels of SLA represents more leaf area per unit of leaf weight . Palg and Aspinal (1981) argue that one of the aspects of adaptation in plants under drought stress is reduction of the leaf dry weight (SLA less ). There was no significant effect of stress on specific leaf weight SLW . But by increasing the stress this amount compared to the 20% of drought stress treatment increased. In lack of water in order to reduce plant transpiration

and water retention, leaf area are reduced, that this topic associated with the increasing of leaf thickness. Flavrs *et al* (1997), examined specific leaf weight increase because of salinity stress on plants exposed to salinity and expressed its reason the reduction in leaf area and leaf thickness increasing. Ali Mohammadi *et al* (2012) found a significant negative correlation between leaf area and SLW. In a study of Katan Dvylsvn *et al* (1987 ) determined that although under the stress leaf area reduce, but leaf specific weight due to increasing of leaf thickness increases. Water content per unit leaf area was not significant. The most value in 80 % treatment and the lowest was in 20% drought treatment. The reason was for maintaining the lost water content of the leaves.

In experiments Ghorbanli *et al* (2010 ) the investigation of effect of drought stress on Rape and the index (LWCA) showed that with increasing stress levels the index increased only in the presence of ascorbic acid and in the absence of the substance (LWCA) declined. Shariat and Osareh (2006 ) found in a study on eucalyptus that the effects of drought on this index was significant and by reducing leaf inflammation LWCA decreased and also reduced the total biomass . The effect of treatments on chlorophyll a was significant at the 5% level (**Table 3**). It was

observed that the amount of chlorophyll a in the table mean comparisons between 50 and 80 % draught treatments were not significant, but at separately each of these treatments with the control treatment were significantly different. The highest chlorophyll a in the treatment of 20 % water and the lowest was related to 80 % draught treatment (**Table 4-7**). According to **Table 3**, chlorophyll b was significant at 1%, in the study of Mean comparisons of chlorophyll b significant differences were between the three treatments. The highest number was related to 50% draught treatments. The lowest was allocated to 80% treatment (**Table 4**).

Total chlorophyll was significant at the 1% level (**Table 3**). According to Table mean comparisons among the three treatments significant differences were found. 20% treatment had the highest chlorophyll content and the lowest was related to 80 % draught treatment (**Table 4**). The results obtained are consistent with different tests including (Yoda *et al.*, 2003), (Antolin *et al.* , 1995). They found that the chlorophyll content decreased with increasing tension. The results suggest that chlorophyll content of leaf decreases with increasing stress levels. Anthocyanin at 5% were affected by the experiment treatments (**Table 3**) . In anthocyanins mean comparison investigation, the results of 50% and 80 %

were significantly different from control treatments. The two treatments were not significantly different from each other (Table 4). Vatkinsvn *et al* (2006) and Mvndry and colleagues (2003) found that stress increases anthocyanin. These compounds as physiologically active substances and as absorbing play an important role in the plant resistance against stress (Tatyny *et al.*, 2004). The carotenoid content variance analysis was significant at 5 % (Table 3). Significant differences between the three drought

treatments were observed in the table mean comparisons. The highest carotenoid content was related to low stress and the lowest value occurred in 80% draught treatment (Table 4). Mvnh- Bush and Pnvala (2004) found under severe stress, the chlorophyll and carotenoid content decrease 63 % and 75 % respectively. They believe that the sharp decline of carotene can be attributed to singlet oxygen produced in Tylakvyyd . It seems with increasing of stress the carotenoid content is looking decreasing trend.

Table 1: Analysis of variance of physiological in vegetative stage

Relative content	Water balance	Specific leaf weight	Specific leaf area	Degree of freedom	Changes resources
3.44	0.039	0.0007	17.33	2	Block
26.78	0.013	0.0004	2.83	2	stress
1.44	0.008	0.0003	5.36	4	error

\*.\*\*: Respectively indicate significance at the 5 and 1 per cent.

Table 2: Comparison of simple effect average of treatments on some physiological characteristics in vegetative phase

relative water content (percent)	water per unit leaf area (grams per square centimeter)	specific leaf weight (grams per square centimeter)	specific leaf area (square centimeters per gram)	Treatment
				Draught stress
79a	0.44a	0.067a	13.87a	20%
79a	0.54a	0.084a	11.95a	50%
74a	0.56a	0.087a	12.31a	80%

Numbers in each column that is common in a word, have no significant difference based on (LSD) test at 5% probability

Table 3: analysis of variance chlorophyll, anthocyanin and carotenoids

Mean square					Freedom degree	Changes resources
carotenoids	anthocyanin	Total chlorophyll	Chlorophyll b	Chlorophyll a		
0.147	5.78*10 <sup>-8</sup>	2.364	0.344	1.07	2	Block
2.039*	1.79×10 <sup>-6</sup>	53.64**	19.44**	35.09*	2	stress
0.124	1.16×10 <sup>-7</sup>	0.493	0.012	1.81	4	error

\*.\*\*: Respectively indicate significance at the 5 and 1 per cent

**Table 4 Comparison of the effect of chlorophyll, anthocyanin's and carotenoids**

carotenoids (milligrams per liter)	anthocyanins (milligrams per liter)	total chlorophyll (milligrams per liter)	chlorophyll b (mg)	chlorophyll a (mg)	Treatment
					<b>Draught stress</b>
<b>215.97a</b>	<b>0.0045a</b>	<b>375.26a</b>	<b>192.95b</b>	<b>179.80a</b>	<b>20%</b>
<b>215.76b</b>	<b>0.003b</b>	<b>372.36b</b>	<b>196.78a</b>	<b>175.49b</b>	<b>50%</b>
<b>214.45c</b>	<b>0.0039b</b>	<b>366.90c</b>	<b>191.96c</b>	<b>174.32b</b>	<b>80%</b>

Numbers in each column that is common in a word, have no significant difference based on (LSD) test at 5% probability

## CONCLUSION

In general conclusion it can be said that the stresses imposed on the amount of chlorophyll, anthocyanin and carotenoids had a negative effect. The most reduction was related to the 80 % draught treatment.

## REFERENCE

- [1] Akbarinia A, Khosravi fard, Sharifi Ashouri Abadi A , Babakhan lo p . 1384. Effect of irrigation on yield and agronomic characteristics of buckwheat. Journal of Medicinal Plants Research Vmtr Iran, 74 : 21-65 .
- [2] Ali Mohammadi M, Mir Mohammad Meybodi A M, 1390. Factor Analysis of Agronomic and physiological characteristics of ten cultivars of wheat in the two water regimes. Production Gyahay Journal, Vol. XVIII, No. 2: 61-67.
- [3] Ghorbanli M, Farzami sphere M, F Norouzi . 1389. Study on the effects of

drought and Ascorbic Acid on two kinds of Rapeseed and soybean response to the treatment plant extracts. Journal of Agro plant physiology Ahvaz Branch 2 ( 7 ) : 73-92 .

- [4] Hassni AS . 1385. Evaluation of dehydration stress on growth, yield and oil content of Dracocephalum moldavica . Journal of Medicinal Plants Research Vmtr Iran , 261 : 22-250 .
- [5] Hekmat Shoar , H . ( 1372). Plant physiology under difficult conditions . (Translation ) . Nick-Nam publisher of Tabriz , 251 pages.
- [6] Levitt J. 1980. Response of plants to environmental stresses. Water, Radiation, Salt stresses. Academic Press. . Vol. 2, PP: 697
- [7] Mozafarian V . 1375. Dictionary of Plant Names . Publication of

- contemporary culture , Tehran . 750 pages.
- [8] Munne- Busch S, Alegre L. 1999. Role of dew on the recovery of water-stressed on *Melissa officinalis* L ., *Jornal of plant Physiology*. 154: 759-766.
- [9] Munnes R. 2002. Comprative physiology of salt and water stress. *Plant cell environment*. 25: 239- 250.
- [10] Omid Begay R 1379 . Approaches of production and processed pharmaceutical plants . Volume I , Second Edition , published by Publication Designers , Tehran . 283 pages.
- [11] Paleg I G and Aspinal D. 1981. Tthe physiology and biochemistry of drought resistance in plants. *Academic Press*. PP 492.
- [12] Safi Khani F , Haidari Sharif Abad, h , Siadat A , Sharifi Ashurabadi, A , Sydnzhad M. Abbaszadeh b . 1386. Effects of water stress on yield and morphological characteristics of the medicinal plant *Dracocephalum moldavica*, *Journal of Medicinal and Aromatic Plants Research*, 23 ( 2 ) : 183-194
- [13] Samsam Shariat H. 1374. Medicinal plants grow and reproduce. Manny publications . 420 pages.
- [14] Wilson R F, Burke JJ, Quisenberry J E. 1987. Plant morphological and biochemical responses to field water deficits. II. Responses of leaf glycerolipid composition in cotton. *Plant Physiology*. 84: 251-254.
- [15] Watkinson A J, Murby E J, Costanzo S D. 2007. Removal of antibiotics in conventional and advanced wastewater treatment: implications for environmental discharge and wastewater recycling. *Water Researche*. 41:4164–76.
- [16] Yoda H, Yamaguchi Y, Sano H .2003. Induction of hypersensitive cell death by hydrogen peroxide produced through polyamine degradation in tobacco plants. *Plant Physiology*. 132: 1973–1981.
- [17] Zargari A 0.1370 . Herb , Publishing and Printing Institute of Tehran University 0.528 : 2 -531 .
- [18] Ziaee A , Dast Pak A , Nqdabady H , Pourhosseini L Hemmati Moghaddam R, Ghorori Naini . 1383. A review of the artichoke plant, *Herb Quarterly*, 1 : 13-10.