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Taxonomical Study in the Desert Plant *Calligonum comosum* L`Her from Two Different Locations in Saudi Arabia

Wafaa K. Taia and Moudy O. El-Etaby
Department of Botany, Alexandria University, Faculty of Sciences, Alexandria, Egypt

Abstract: Taxonomical characters within the species *Calligonum comosum* L`Her have been studied grown in two different deserts in Saudi Arabia, Nefoud El-Shakika and El-Dahnaa. Vegetative morphological characters, especially plant length and width, showed great variations within the plant collected from the two different regions. Floral morphological characters are more stable, except the fruit color which was different in the two deserts. Anatomical characters as well as mineral contents varied in response to change in locations. The variations in these characters are discussed according to the difference in climates and water availability.

Key words: Floral morphology, vegetative morphology, vegetation anatomy, plant adaptation, fruit morphology, mineral contents

INTRODUCTION

Calligonum comosum L`Her is a large perennial bush, found in desert scrub and waste in any climatic zone. It inhabits much of the North African desert, the desert sands of the Middle East, Pakistan as well as the sand dunes in both central and eastern Arabia (Lipscombe Vincent, 1984). This species belonging to family polygonaceae and characterizes by being tall, evergreen shrub reaching up to 3 m in length, but is usually found in bush from 1 to 2 m high. The woody hard stem is white to grayish-white with swollen nodes. It looks leafless, as hard, widely branched plant, but young branches are green and thin with very small caduceus leaves (Chaudhary, 1999). The stiff, green branches produce an abundance of flowers in the early spring months (March and April). Flower pedicels are as long as or longer than the perianth. The silvery-white sweet smelling little blooms are followed by the hairy fruits which are yellowish green, yellow or even shades of red (Chaudhary, 1999). The fruits covered by long hairs which arising from four vertical wing-like narrow ridges. The plant has a long tap root which enables the plant to collect sand and used as sand dune stabilizer (Zoghet and Al-Alsheikh, 1999).

This plant has a lot of uses by Bedouins; they used the woody stem as firewood in winter. The long and far reaching roots make it a good sand stabilizer and the sand is often heaped around it in large hummocks (Lipscombe Vincent, 1984). It is used in hedges, ground cover, windbreaks and landscaping. Its fresh flowers can be eaten as it is high in sugar and nitrogenous components (Surviva-Appendix B, 2002). The plant has been used to treat stomach ailments by local healers and the stems and leaves are chewed for curing toothache (Liu *et al*., 2001). Its root decoctin is used for gum sores (Zoghet and Al-Alsheikh, 1999).

For all of these economical uses, the plant has been faced with unorganized rural activities which led to the extinction of it in many places. For this and because of the little available information about that species especially its taxonomical plasticity under the arid conditions which it faces and as a step forward to know the ways its internal and external features adapted to the environmental stress, this work has been done.

The aim of this study is to elucidate both morphological and anatomical variations present in *Calligonum comosum* L`Her grown in two apart deserts in Saudi Arabia; Nefoud El-Shakika and El-Dahnaa; as both have different soil characters and climatic conditions. Also, we want to know the ways of adaptation the plants have to accommodate with the poor soil, severe climatic conditions and the water deficit in these arid habitats.

MATERIALS AND METHODS

Two sites have been chosen in Saudi Arabian deserts, one in Nefoud El-Shakika south Onyza city on Najd plateau and the second west El-Dahnaa in the way between El-Riyadh city and El-Damam, Kingdom of Saudi Arabia. Each of these locations were dominated by *Calligonum comosum* L`Her beside other species such as *Artemisia monosperma, Ephedra elata* and *Haloxylon ammodendron*.

Corresponding Author: Wafaa K. Taia, Department of Botany, Alexandria University, Faculty of Sciences, Alexandria, Egypt

Plants were collected from the two regions in February and March 2003. Parts of the stem have been taken from at least 10 plants from each location; Nefoud El-Shakika and El-Dahnaa; for investigations. Flowers and fruits have been collected in March and April of the same year. These specimens have been subjected to the following investigations:

- Parts of the stems have been examined by both Stereo and Scanning microscopes to examine the external surface.
- Recent parts of the stems have been sectioned transversely, manually, to examine the difference in internal structures.
- Longitudinal sections in the stems have been examined by the scanning electron microscope, in order to examine the wood vessels.
- Anthers, pollen grains and fruits have been examined by both stereo- light and scanning microscopes.
- Small pieces of the stems have been subjected to x-ray analyses, in order to known the variations in element contents within the two locations.

All the measurements are in centimeter except those for pollen grains are in micron. At least 10 plants are measured, the measured nodes and internodes are those number five from the terminal bud. Measurements of the fruits include the hairs covering it till the tip of the hairs. Statistical analysis using SPSS programs of the measurements showed insignificant variations between the studied specimens of each location, while variations in vegetative characters can be considered between the two locations.

RESULTS

From Table 1 and Fig. 1, we can notice that the size of the plant, both length and width, differ between both habitats. In Nefoud El-Shakika, the plant is taller in general, but it has different width (Fig. 2), while in El-Dahnaa the maximum length of the plant is greatly shorter than that in the previous region during the same time while the mean of the width are slightly bigger (Fig. 3). The stem color grayish or grayish white with inter-node length reach 6.6 cm in Nefoud El-Shakika and never exceed 4.5 cm in El-Dahnaa. The nodes are generally swollen and reach 1.3 cm in the first region and become slightly larger in the second region.

The flowering time differs in the two sites, as it starts in the mid of February in Nefoud El-Shakika and delayed about two weeks in El-Dahnaa. This is followed by the fruiting time which is after the flowering time by two weeks. The fruits are rectangular in shape with four longitudinal rows of hairs. The length of the fruits is about one cm in both regions, but their colors differ in both regions. In Nefoud El-Shakika, the fruit color is mostly yellow with few ones yellowish-pink (Fig. 4), while in El-Dahnaa region the fruits are mostly red with few ones yellowish-pink (Fig. 5). The hairs covering the fruits are about 2 mm. in length with straight ends. The surface view of the fruit cells appear to be elongated with straight walls and longitudinal cutin striations on upper walls of Nefoud El-Shakika fruits (Fig. 6) and undifferentiated in El-Dahnaa ones which are completely covered by needle-shaped wax secretions (Fig. 7).

The anthers are connected to the filaments in versatile position (Fig. 8); the epidermal cells are diametric with striated epicuticular secretions (Fig. 9). The pollen grains are symmetric, iso-polar and perprolate in shape, they have three colpi which are extent towards near the poles (Fig. 10). Pollen length and width as well as the colpi length do not differ greatly between the two regions (Table 1).

Table 1: Morphological characters studied in *Calligonum comosum* L`Her (measurements in cm)

Character/Region	Nefoud El-Shakika	El-Dahnaa
Plant length	95-230 (161.9)	90-140 (126.3)
Plant width	137-380 (245.9)	170-365 (299)
Stem color	Grayish white	Gray
Inter-node length	2.6-6.6 (3.62)	2.0-4.5 (3.28)
Node width	0.2-1.3 (0.62)	0.3-1.6 (o.675)
Flowering time	Mid of February	Beginning of March
Fruiting time	End of February	Mid of March
Fruit color	Yellow, few-yellowish pink	Red, few-yellowish pink
Fruit length	0.7-1.3 (0.99)	0.7-1.3 (1.01)
Fruit-hairs length	0.1-0.25 (0.145)	0.1-0.27 (0.17)
Cutin ornamentation-on fruit cells	Longitudinal-striations	Unobvious
Wax secretions-on fruit cells	Few	Dense
Wax shape on-fruit cells	Granules	Needle-shape
Pollen grain shape	Perprolate	Perprolate
Pollen grain length	33.1-37.2 (35.3 Um)	31.6-36.2 (34.4 Um)
Pollen grain width	18.3-22.2 (20.1 Um)	18.2-21.1 (19.5 Um)
Aperture type	Tricolpate	Tricolpate
Aperture length	31.9-35.6 (34.2 Um)	29.7-34.1 (32.6 Um)

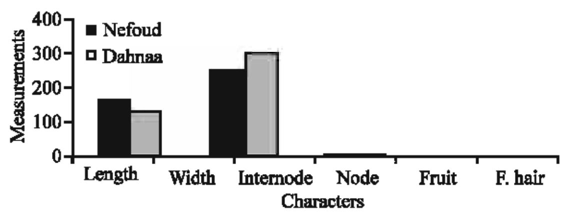

Fig. 1: Variations in mineral contents

Fig. 2: *Calligomum comosom* L`Her in Nefoud El - Shakika

Fig. 3: *Calligomum comosom* L`Her in El-Dahnaa

Fig. 4: Fruits of Nefoud El-Shakika

Fig. 5: Fruits of El-Dahnaa

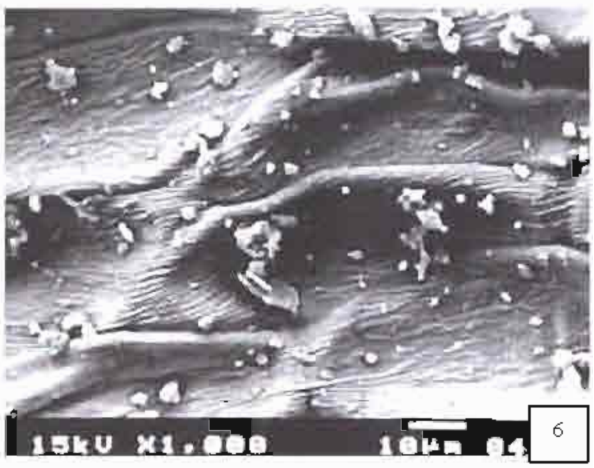

Fig. 6: SEM of the fruit cells of Nefoud El-Shakika

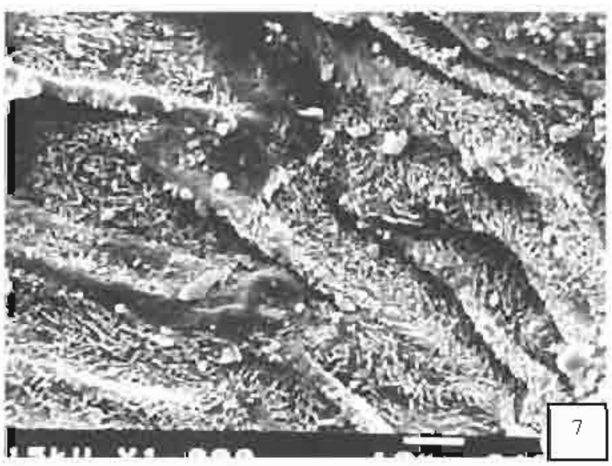

Fig. 7: SEM of the fruit cells of Nefoud El-Dahnaa

Fig. 8: SEM of the whole another, showing versatile attachment with the filament

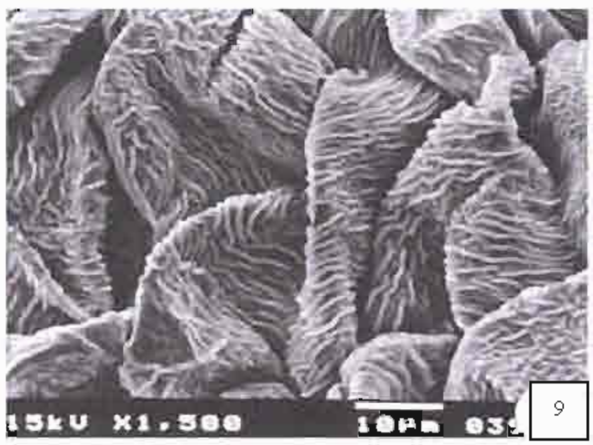

Fig. 9: SEM of part of the another showing the another cells

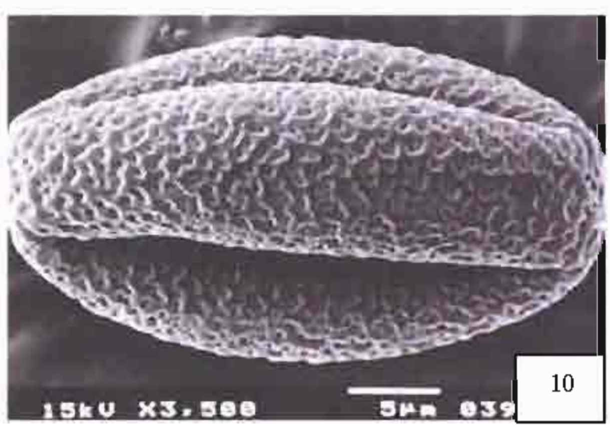

Fig. 10: SEM of the pollen grain

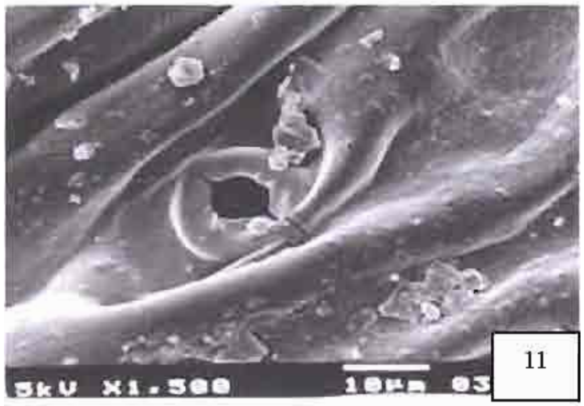

Fig. 11: SEM of the stem surface of Nefoud El-Shakika showing the needle-shaped wax secretions

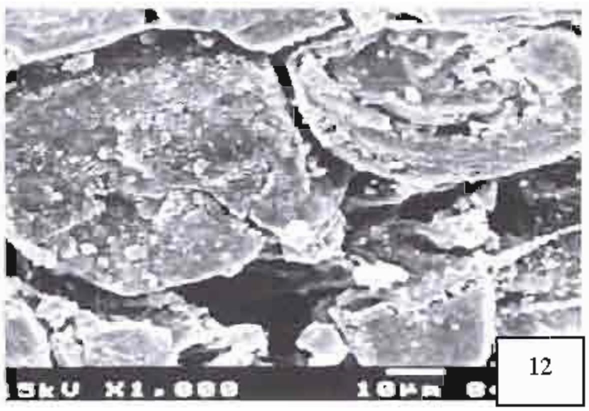

Fig. 12: SEM of the stem surface of El-Dahnaa showing platelets wax secretions

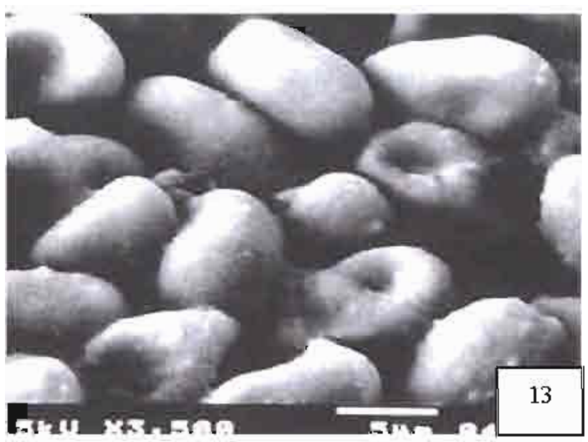

Fig. 13: SEM of the stem of Nefoud El-Shakika showing the papillate epidermal cells

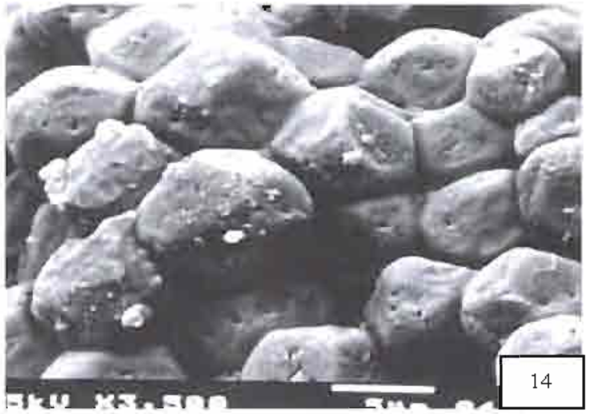

Fig. 14: SEM of El-Dahnaa showing the papillate epidermal cell

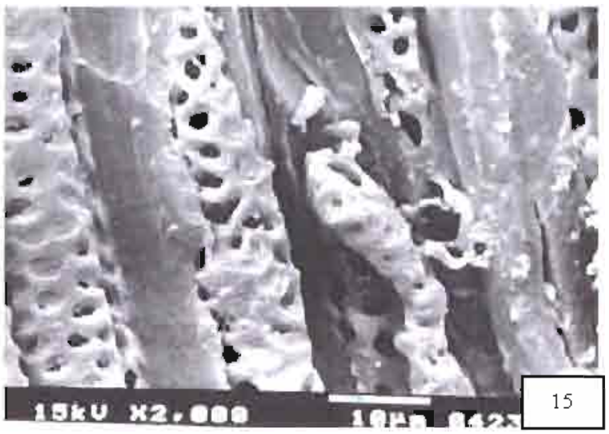

Fig. 15: SEM of the xylem vessels showing the reticulate lignified walls

Table 2 Anatomical characters studied in *Calligonum comosum* L`Her

Character/Region	Nefoud El-Shakika	El-Dahnaa
Cuticle thickness	Thin	Thick
Wax shape	Needle-shaped	Platelets
Stem texture	Mealy	Scaly
Epidermal cell shape	Barrel-shape	Barrel-shape
Sub-epidermal cell	Present	Present
Number of cortex layers	3-5	3-6
Presence of air chambers	Absent	Present
Number of vascular bundles	5-8	5-7
Size of secondary phloem	More than ten layers	Less than seven layers
Type of secondary xylem	Porous	Nonporous
Shape of radial cells	discontinuous, rectangular	Continuous, rectangular

Table 3 Mineral contents in *Calligonum comosum* L`Her

Mineral/Region	Nefoud El-Shakika	El-Dahnaa	Used materials
Mg	2 95	7 03	MgO
Si	4 19	4 99	Quartz
P	2 78	2 06	GaP
S	6 04	2 60	FeS_2
Cl	5 42	14 41	KCl
K	46 44	37 1	MAD
Ca	3 55	6 59	Wollas
Cu	15 35	13 4	Cu
Zn	13 27	11 83	Zn
Sum	100	100	

The texture of the stem is either mealy in the first region, or scaly in the second one. The examination of the transverse sections in the uppermost parts of the stem by light microscope reveals that the epidermal cells covered with a layer of cutin which obviously differs in thickness in the two regions. The epidermal cells are barrel - shaped with a layer of sub epidermal cells composed of compact rectangular parenchyma cells without intercellular spaces. The cortex is composed of three to six layers of chlorenchyma cells. The primary vascular bundles are from five to eight with wide vessels and compressed phloem. The stem quickly starts the secondary growth, which becomes obvious in the vessels and phloem which sooner become circular layers of both secondary phloem and xylem. In this state air-chambers appeared between the cortex and the secondary phloem in the stems of El-Dahnaa region only. The size of the secondary phloem

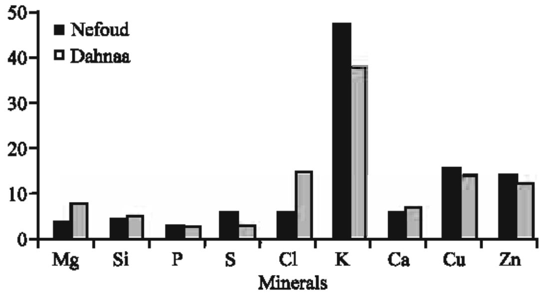

Fig. 16: Variations in mineral contents

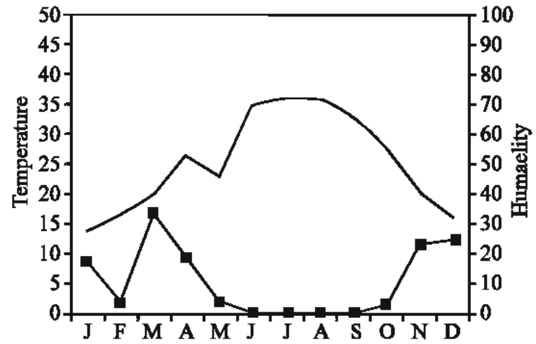

Fig. 17: Climatic sketch for El-Dahnaa desert during the period from 1993-2003

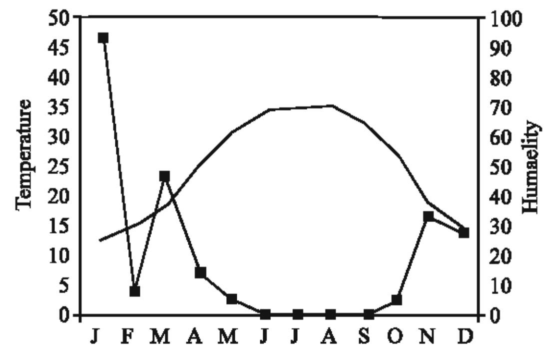

Fig. 18: Climatic sketch for Nefoud El-Shakika desert during the period from 1993-2003

differs as well between the two regions which is larger and more organized in Nefoud El-Shakika than in El-Dahnaa. The type of secondary xylem differs also, as it appears to be porous, with parenchyma cells in between the vessels in Nefoud El-Shakika in contrast to the non porous xylem in El-Dahnaa. The ray cells are rectangular in shape, continuous in El-Dahnaa and discontinuous in Nefoud El-Shakika (Table 2).

The examination of the stem under the scanning electron microscope reveals that there is a wax layer over the stem surface, which is sparse and needle-shaped in Nefoud El-Shakika (Fig. 11) while it is condensed and platelets- shape in El-Dahnaa (Fig. 12). In both regions, there are areas in the epidermis with elevated papillae (Fig. 13 and 14). In longitudinal sections the xylem vessels appears with reticulate lignified walls (Fig. 15).

The Mineral contents in the tissues of the plant differ between the two regions in their examination by x-ray. From Table 3 and Fig. 16, we can notice that Sulfur and Potassium contents are noticeably higher in those grown in Nefoud El-Shakika, while Phosphorous, Cupper and Zinc are bit higher in the same area than those grown in El-Dahnaa. In contrast to Magnesium, Chlorine and Calcium contents which are greatly higher in El-Dahnaa and Silicon is a bit higher as well (Fig. 16).

DISCUSSION

The study of the effect of habitats on the phenotypic characters of wild plants has been a matter of interest since long time ago. This subject has been called phenotypic plasticity which is the way of response to the change in environments. Shaltout *et al.* (1989) found that morphological characters, especially leaf apices and margins, in *Thymelaea hirsute* (L.) Endl. Grown along different environmental gradients in Western Mediterranean region of Egypt have been changed according to both aridity and $CaCO_3$ contents in the soil. Taia and El-Olayan (2003) found that moisture content, leaf characters as well as the length of the plants and their vital status can be affected under different habitats. Meanwhile Taia and El-Ghanem (2004) found that mineral contents of the plants can be affected as well. In *Calligonum comosum* the leaves are deciduous as soon as the plant start growing, thus, we cannot notice any change in the leaves. According to our results the most vegetative characters affected by different habitats are plant length, width and colors. The colors of flowers and fruits can be affected also. But the main parts of the flower as well as anther shape, ornamentation, attachment with filament beside characters of pollen grains are stable. This indicates that floral characters are more stable than vegetative ones. Tomlinson (1984) pointed to the use of vegetative morphological characters in the systematic of higher plants are of limited use than morphological features of the sexual reproductive system due to the belief in the innate conservatism of reproductive features. White (1979) said that the plant body is made up of an indefinite number of repeating units, which he called them modules. These modules have a greater diversity of possible functions and for that the vegetative characters have a great capacity for replication repair in contrast to flowers which have set of functions which are invariable.

Taia and El-Ghanem (2004) found that leaf characters can be used in systematic, while stem characters are more variable. This may be due the modular system proposed by White (1979). Barthlott (1984) gave precise micro structural features of seed surfaces which provide valuable taxonomic information. In this study the fruit micro structural characters are more valuable than fruit color and size. The presence of the multi-cellular appendages in four longitudinal rows is a good character, which is invariable according to different habitat. Cellular arrangement of inter appendages areas are stable as well; the only variable thing is the wax deposition which may be due to climatic and other ecological factors. The density of wax, which is less in Nefoud El-Shakika, can be referred to the climate which is more humid than in El-Dahnaa (Fig. 17 and 18).

The internal structures of desert plants give an idea about their adaptation with the external stress falling on them. Lyshede (1977) studied the structure of the epidermal and sub-epidermal cells of both *Anabasis articulate* and *Calligonum comosum* and found that the epidermal cell walls of the stem, in the two studied species, swelled rapidly during water absorption and released the water slowly when dehydrated. Slatyer (1967) reported that criteria in pine wood and he nominated it as hysteresis. According to our observations, the stem in both regions, covered with wax depositions, beside the cutinized epidermal cells which can protect the cells from water loss. The only places which permit water exchange are the stomata and the lenticels. Meanwhile, Jonsson (1902) noticed the presence of large amount of Mucilage in the epidermal outer wall in *Calligonum* sp. This may be another reason for preventing losing water as mucilage able to absorb and store water. All these anatomical characters; wax deposition, cutinized epidermal cells and mucilage beside the morphological characters indicate to the highly adaptation of this species to the aridity present in the habitats where it present.

The vegetative value of range plants has been studied by many authors. Oelberg (1956) studied the different factors affecting the nutritive value of range forage. Heneidy (1987) studied the nutrient content in range plants grown at Omayed region in Alexandria, While Sharaf El-Din *et al.* (1998) studied the nutritive value of the raudhas plants in central Saudi Arabia. They all found that, the nutritive value of any forage is dependent upon its content of energy - producing nutrients and nutrients essential to body growth. Sharaf El-Din *et al.* (1998) found that the evaluated species have low contents of N, P, K and Na but high contents of Ca, Mg and Mn. Taia and El-Ghanem (2004) the habitats can affect the contents of some minerals in the same species as Fe, Mn, K and Zn during the three seasons (autumn, winter and spring). In our results, the mineral content is generally low, except the potassium which is moderate in the studied regions. In spite of that, we can notice that Mg, P, S, Cl and Ca contents varied between the two regions. This means that the mineral content is affected by the habitats and accordingly the nutritive value of the plant can be affected. Abdel-Salam (1985) found that the ratio of Ca:P is the most important thing in the animal diet, as he said that it is preferred to be from 2 to three. In *Calligonum comosum* this ratio is more than three in El-Dahnaa region (6.59/2.06), while it is less than two in Nefoud El-Shakika (3.55/2.78) which means that nutritive value of range plants can be affected in the different habitats.

From this study, we can say that *Calligonum comosum* L`Her is completely adapted with the arid habitats, both morphologically and anatomically. The morphological characters can be altered according to environmental changes, but the floral characters are more fixed but those concerning the colors are affected with the mineral composition of the soils. Anatomical characters, especially those related to protection, altered according to the stress the plant face especially climatic stress. Mineral contents are affected by the habitats, as well; accordingly the nutritive value of the plant can be changed in the different habitats and under different climatic factors.

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