



## **Evaluation of the phenotypic and physiological diversity of selected wild plants in the Al-Muthanna desert**

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### **Abstract**

This study aimed to assess the phenotypic and physiological diversity of selected wild plants in the Al-Muthanna Desert, focusing on their adaptability to harsh desert environmental conditions. The study included an analysis of several phenotypic characteristics, such as leaf, stem, and root features, as well as the estimation of physiological indicators, including chlorophyll content and relative water content. The relationship between phenotypic and physiological characteristics was also analyzed to reveal the adaptation mechanisms employed by these plants in arid environments. The results showed significant variation among the studied species (*Achillea santolina* L., *Citrullus colocynthis* L., *Astragalus spinosus* (Forssk.) Muschl., *Artemisia herba-alba* Asso. *Haloxylon salicornicum* (Moq.) Bunge ex Boiss., *Teucrium polium* L., *Launaea mucronata* (Forssk.) Muschl., *Apium graveolens* L., *Lycium barbarum* L., and *Capparis spinosa* L.) in most of the measured characteristics, reflecting different adaptation strategies that enable them to survive and thrive in desert conditions. This study provides a scientific basis for understanding the adaptation of wild plants to arid environments and can serve as an important reference for biodiversity studies and plant resource conservation in desert regions.

**Keywords:** Plants, Physiological, Relative Water Content, Chlorophyll, Morphological Characteristics

## Introduction

Plants and humans have a complicated connection that dates back to our shared evolutionary past. Today, people and animals all across the world rely on plants for food, medicine, and energy, demonstrating this heritage. Agriculture and the domestication of plants made it possible for human civilization to advance and for our communities to become more sophisticated. As a result, the steady and dependable production and transportation of food is essential to our contemporary cities and cultures[1].

The most difficult environments for plant growth are deserts because of their extreme heat and dryness. Despite this, they are home to a wide variety of plants that have adapted to survive and thrive in arid conditions, enabling them to endure the harshness of the desert environment).[2]

In order to overcome water scarcity, desert plants have developed a variety of adaptation strategies. They were able to preserve water by developing succulent structures in their bodies. In the absence of a water supply, succulent plants' capacity to retain water in live tissue may be used to maintain metabolic activity).[3]

Some plant species from the desert have therapeutic significance because they contain physiologically active chemicals including teixitol, pyrene, and chametothecin, which are created by internal bacteria of medicinally essential plants and used in medicine and agriculture [4].

Compared to plants in moderate environments, plants in deserts have thinner and narrower leaves, which is a crucial developmental above-ground characteristic

that enables them to reduce water loss via transpiration. Numerous desert plants have an excessive density of stomata on every side of the leaves, which increases CO<sub>2</sub> exchange. Moreover, a greater rate of photosynthesis and CO<sub>2</sub> diffusion through the cell walls are made possible by the vast internal surface area formed by their isolaral mesophyll with palisade cells rich in chloroplasts at both leaf surfaces. Additionally, the root distribution, topology, morphology, and tissue architecture of desert plants have all been modified to accommodate the dry and barren environment. A strong root system ensures anchoring in the soil and effective absorption of nutrients and water for the best possible development [5]

This study aims to study and evaluate the phenotypic, physiological diversity of some of the selected wild plants in the Al-Muthanna desert, and to indicate their ability to adapt to the desert environmental conditions. The study includes some of the characteristics of leaves, stems and roots, as well as estimating the content of chlorophyll, and the relative water content, and the analysis of the relationship between traits phenotypic, and physiological of studied plants.

## Materials and Methods

The study area is located on the eastern side of Al-Salman district within the borders of Al-Muthanna Governorate, specifically wadi Al-Kharaz, wadi Abu Sajla, and the Al-Salkata area in District 1/24. Its geographical location is 30 57 27 N 45 03 19 E is 13 km above sea level. The study relied primarily on fresh plant samples collected from the study.

Ten plant species were collected (*Achillea santolina* L., *Citrullus colocynthis* L., *Astragalus spinosus* (Forssk.) Muschl., *Artemisia herba-alba* Asso. *Haloxylon salicornicum* (Moq.) Bunge ex Boiss., *Teucrium polium* L., *Launaea mucronata* (Forssk.) Muschl., *Apium graveolens* L., *Lycium barbarum* L., and *Capparis spinosa* L.), with three samples of each species, and placed in plastic bags labeled with serial numbers (1-10), each number representing a plant species. A plant specimen of each plant species was deposited in the herbarium of the College of Pharmacy at Al-Muthanna University after identification, recording the scientific names of the studied plants, the families to which they belong, and the essential information required for each plant specimen's identification. The specimens were then pressed and preserved in the herbarium. Samples of the tender vegetative parts of each plant were also preserved in glass bottles and placed in a refrigerator for the purpose of genetic and physiological study.

The phenotypic study was conducted at the study site and in the laboratory by recording several measurements for each part of the plant, including the characteristics of stems, roots and leaves such as (length, diameter, shape, color, width, type, in addition to

studying other characteristics). Measurements were taken using a standard ruler, measuring tape, vernier scale (diameter measuring instrument), and magnifying glass. The plants and some plant parts were photographed using a Canon camera, and the differences in color, shape, and measurement were documented in tables and figures. Some observations were also recorded from the study site, such as a description of the location, soil diversity, altitude above sea level, as well as the nature and sustainability of the plants studied. The chlorophyll content (a, b, and total) in plants was estimated based on the method Mac Kinney (1941) according to Goodwin (1976). Measuring relative water content (R. W. C.) according to Weatherley (1950).

## Results and Discussion

The studied plant species were divided into two groups according to their growth habit: the first and larger group consists of small shrubs (60%), while the second group consists of herbs (40%). In terms of duration, it was divided into three groups:

A group of perennial species that have strong taproots that extend into the soil, resist drought, and live in depressions and

valley edges, including eight species (*Achillea santolina* L., *Citrullus colocynthis* L., *Astragalus spinosus* (Forssk) Muchl., *Artemisia herba alba* Asso., *Haloxylon salicornicum* (Moq.) Bunge ex Boiss., *Teucrium polium* L., *Lycium barbarum* L., *Capparis spinosa* L.).

The group of annual species that live for one year and includes only one species, which is (*Launaea mucronate* (Forssk) Muchl.).

The group of biennial species that live for two years; in the first year, stems and leaves grow, and in the second year, flowers and seeds develop. This group includes only one

species, which is (*Apium graveolens* L.) It lives in sandy soils.

The studied plants varied in their height from the ground surface; The highest recorded height was in a plant (*Astragalus spinosus* L.) where it reached (51cm) while the lowest height is (11cm) in a plant (*Citrullus colocynthis* L.). (Table 1 shows the above). After classifying the plants, it was found that the majority of plant species in the study area belonged to the Asteraceae family, constituting 33% of the studied plants. This aligns with the findings of [6] which indicate the dominance of the Asteraceae family.

**Table 1.** Nature, permanence, and height of plants

Scientific name	Family	Nature of growth	Durability	Plant height
<i>Achillea santolina</i> L.	<i>Asteraceae</i>	Herbal	Perennial	40 cm
<i>Citrullus colocynthis</i> L.	<i>Cucurbitaceae</i>	Herbal	Perennial	11 cm
<i>Astragalus spinosus</i> (Forssk.) Muschl.	<i>Fabaceae</i>	Shrub	Perennial	51 cm
<i>Artemisia herba-alba</i> Asso.	<i>Asteraceae</i>	Shrub	Perennial	45 cm
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	<i>Amaranthaceae</i>	Shrub	Perennial	31 cm
<i>Teucrium polium</i> L.	<i>Lamiaceae</i>	Shrub	Perennial	16.5 cm
<i>Launaea mucronata</i> (Forssk.) Muschl.	<i>Asteraceae</i>	Herbal	Annual	15.5 cm
<i>Apium graveolens</i> L.	<i>Apiaceae</i>	Herbal	Biennial	20 cm
<i>Lycium barbarum</i> L.	<i>Solanaceae</i>	Shrub	Perennial	27 cm
<i>Capparis spinosa</i> L.	<i>Capparaceae</i>	Shrub	Perennial	12 cm

The roots are characterized by a taproot system in all studied species. Differences were observed in some characteristics of plant roots, including variations in root length and diameter, color, and the nature of branching in secondary roots. The shortest root length was recorded in (*Launaea mucronate* (Forssk) Muchl.) and is locally called (Al-Awaina) and reached (7 cm), while the longest root length was recorded

in plant (*Citrullus colocynthis* L.) where it reached (66 cm) and is known locally as (Al-Hanzal or bitter apple). The diameters varied between (4.8 mm) in (*Artemisia herba alba* Asso.) to (25 mm) in (*Haloxylon salicornicum* (Moq) Bunge ex Boiss.). As for the shapes of the roots, they were mostly cylindrical, some were spindle-shaped, conical, and irregular in shape. Their hues range from yellowish-white to dark or light

brown. The degree of hardness also varies, depending on the plant's age and soil type. Regarding root branching, some roots diverge at their base at the top layer of soil and spreads horizontally. Other may branch at the root tip or deeper, especially in dry or heavy soils. Some roots are unbranched, while others have dense root hairs, as in plant (*Teucrium polium* L.), and still others

have few root hairs. This is shown in the Table (2). Herbs and some small shrubs with root branches close to the soil surface help to stabilize the plant and also benefit from rainwater. Most shrubs with long, unbranched roots or roots that branch at the root tip away from the soil surface help to stabilize the plant and benefit from groundwater. This was confirmed by [7]

**Table 2.** Characteristics of the root

Scientific name	Length(cm)	Diameter (mm)	Branching	Color
<i>Achillea santolina</i> L.	16	7	Branching at the summit	Dark brown
<i>Citrullus colocynthis</i> L.	66	21	Branching near the base	Yellowish white
<i>Astragalus spinosus</i> (Forssk.) Muschl.	28	7	Unbranched	Pale brown
<i>Artemisia herba-alba</i> Asso.	25	4.8	Unbranched	Pale brown
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	29	25	Branching at the top into two branches	Yellow with Blak in it
<i>Teucrium polium</i> L.	18	5	Side branches along the root	Pale brown
<i>Launaea mucronata</i> (Forssk.) Muschl.	7	5	Many taproots emerge From the base the stem	Dark brown
<i>Apium graveolens</i> L.	22	21	Unbranched	Brownish white
<i>Lycium barbarum</i> L.	18	11	Branching at its end into two branches	Yellowish white
<i>Capparis spinosa</i> L.	52	8	Lateral branches in multiple areas of the main root	Pale brown

All the stems of the studied plants are upwards except for two types (*Citrullus colocynthis* L., *Capparis spinosa* L.), whose stems are horizontal, creeping and extended. Some of the upward stems are upright, some are arched, and some are upright with lateral branches. The stems differ in length, thickness and shape. The longest recorded

stem is that of plant (*Capparis spinosa* L.), where its average length reached (160 cm), while the shortest recorded stem is that of plant (*Apium graveolens* L.), which reached (11 cm). The highest value for diameter is (14.5 ml) in plant (*Apium graveolens* L.) and the lowest value is in plant (*Capparis spinosa*) where it reaches (1.7 ml). All the

studied plants have cylindrical stems except for (*Citrullus colocynthis* (Forssk) Muchl.), whose stems are angular. Stem colors rate between pale green to grayish-green, dusty green, brown, whitish-brown, or yellowish. Branching can occur along the stem, at the base, at nodes, in a circular pattern, or as fused branches at the apex. All the studied plants consist of several stems emerging from the root base and branching into secondary branches.

This study showed that the stems of herbaceous plants are either short, as in plant (*Apium graveolens* L.), or long and

creeping, as in plant (*Citrullus colocynthis* L.). They are soft, usually green, and have few branches. These qualities decrease water loss and resistance the desert storms. As for the stems of shrubs, they are partially or completely woody, most of them are multiple and branched at the base, or they are relatively short. Their color is dusty, gray, yellowish, or whitish, reflecting sunlight to reduce the transpiration process. Also, the characteristic of shortness and branching from the base reduces the intensity of the winds.

**Table 3.** Characteristics of the stem

Scientific name	Length (cm)	Diameter (mm)	Color	Branching	Growth trend	Stam shape
<i>Achillea santolina</i> L.	47	10.4	Brownish yellow	Branching Along the stem	Ascending arch	Cylindrical
<i>Citrullus colocynthis</i> L.	120	4.6	Pale green	Branching at The base	Horizontal creeping	Rigged
<i>Astragalus spinosus</i> (Forssk.) Muschl.	51	5.5	White brown	Branching Along the stem	Upright and It branches are slanted	Cylindrical
<i>Artemisia herba-alba</i> Asso.	45	2.8	Pale green	Several branches At the base it has side branches	Upright with a simple curve	Cylindrical
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	48	2.9	Green brown	Several branches Emerge from nodes	Ascending arch	Cylindrical
<i>Teucrium polium</i> L.	18	2	Light green Almost white	Branching at the base	Upright	Cylindrical
<i>Launaea mucronata</i> (Forssk.) Muschl.	20	3	The old is yellow And the new green	Branching Along the stem	Ascending arch	Cylindrical
<i>Apium graveolens</i> L.	11	14.5	Brown	Several branches United and ranced at the summit	Upright and It branches are slanted	Cylindrical
<i>Lycium barbarum</i> L.	27	3.6	Dusty green	Several branches At the base intensively	It is greatly arched	Cylindrical
<i>Capparis spinosa</i> L.	160	1.7	Pale green	Branching along the stem	Horizontal creeping	Cylindrical

This study showed that all the selected plant species adapted their leaves to the harsh environmental conditions of drought, intense sunlight, and high temperature by reducing their size, resulting in small leaves or leaves with a lobed blade and the presence of hairs or down reduces the surface area for water evaporation through transpiration, which is consistent with what was mentioned previously [8]. Some species have single, simple, scaly leaves, as in plant (*Achillea santolina* L.), some have simple, lobed leaves, as in colocynth (*Citrullus colocynthis* L.), some have compound, pinnate leaves, as in (*Astragalus spinosus* (Forssk) Muchl.), or compound, trifoliate leaves, as in (*Apium graveolens* L.). As for plant species (*Haloxylon salicornicum* (Moq) Bunge ex Boiss.), it is bare and does not contain leaves. The blade shape varies; in some species it is oval, while in others it is disc-shaped, circular, pinnately lobed, trilobed, or lanceolate. The plant species

(*Citrullus colocynthis* L.) had the largest blade surface area among the studied species, measuring (9 x 6) cm, while the plant species (*Teucrium polium* L.) had the smallest blade, measuring (7 x 1.5) mm. The tip of the blade may be rounded, pointed, tapered, or recessed, and the base of the blade may be wide, rectangular, rounded, or fused to the stem. Some plant species have petiolate leaves connected to the stem by a stalk, while others have sessile leaves that are attached to the stem. Plant species (*Astragalus spinosus* (Forssk) Muchl.) and (*Artemisia herba alba* Asso) have compound, petiolate leaves, while the leaflets that comprise them are sessile and unpetioled. The color ranges from light green to dark green to gray-green, as well as silver-green. The silver color is due to the density of hairs on the leaf surface, as in (*Achillea santolina* L., *Teucrium polium* L., and *Lycium barbarum* L.). The Table (4) shows what was mentioned above.

**Table 4.** Characteristics of the leaves

Scientific name	Leaf type	Length of the blade	Offer of the blade	Shape of the blade	Top of the blade	Base of the blade	Presence of the neck
<i>Achillea santolina</i> L.	Single simple squamous	1.5 cm	0.8 cm	Shallow lobed feathery	Sub round	A broad Fused with stem	Sessile without neck
<i>Citrullus colocynthis</i> L.	Single simple	9 cm	6 cm	Deeply lobed feathery	Pointed	Cordial	Petiolate
<i>Astragalus spinosus</i> (Forssk.) Muschl.	Double compound feathery leaf	0.7 cm	0.3 cm	The leaflet is oval	Pointed	Round	The leaf is Petiolate while Leaflet is sessile
<i>Artemisia herba-alba</i> Asso.	It three parts compound	0.9 cm	0.2 cm	Oval to lanceolate	Acute	Round	The leaf is Petiolate while Leaflet is

							sessile
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	Lost leaves	-	-	-	-	-	-
<i>Teucrium polium</i> L.	Single simple	0.7 cm	0.2 cm	Oval to lanceolate	Round	Rectangular	sessile
<i>Launaea mucronata</i> (Forssk.) Muschl.	Simple divided by partitions	2.5 cm	0.5 cm	The shape of an Inverted spear	Pointed	Narrow Fused with neck	Petiolate
<i>Apium graveolens</i> L.	It three parts compound	3 cm	2.7 cm	Palmy lobed	Sunken	Round	Petiolate
<i>Lycium barbarum</i> L.	Simple and compact	0.4 cm	0.4 cm	Oval or round	Round	Round	Petiolate
<i>Capparis spinosa</i> L.	Simple	1.8 cm	1.7 cm	Oval	tapered	Broad	Petiolate

After conducting the analysis of variance, the average concentrations of each type of chlorophyll A, B, and total chlorophyll were compared between the studied plant species after calculating the least significant difference at a variance level of 0.05, as shown below:

Table (5) shows clear significant differences in the average chlorophyll a content between the studied plants. The highest average was in the plant (*Astragalus spinosus* (Forssk) Muchl.), which reached (19.213) mg, and this is significantly different from (*Apium graveolens* L.), which has the lowest average concentration of chlorophyll a, which reached (2.816) mg. Other plants have similar concentrations, such as (*Launaea mucronate* (Forssk) Muchl.) with a concentration of (5.524) mg, which is close to (*Artemisia herba alba* Asso.) with an average concentration of (4.325) mg, and (*Achillea santolina* L.) with (*Capparis*

*spinosa* L.) with concentrations of 16.459 and 15.526 mg respectively. Meanwhile, (*Lycium barbarum* L.) with an average concentration of (6.999) mg is almost equal to (*Citrullus colocynthis* L.) with a concentration of (6.861) mg.

Table (5) indicates that there are significant differences in general between the average chlorophyll b content. It also shows that the average chlorophyll b in (*Astragalus spinosus* (Forssk) Muchl.) is the highest, reaching (6.007) mg, and the average chlorophyll b content in (*Apium graveolens* L.) is the lowest, reaching (0.925) mg, (*Astragalus spinosus* (Forssk) Muchl.) is close to (*Achillea santolina* L.) and (*Capparis spinosa* L.) with a slight difference, and their average concentrations reached (5.657, 5.313) mg respectively. (*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.) (3.573) mg is close to (*Teucrium polium* L.) (3.705) mg, and (*Launaea*

mucronate (Forssk) Muchl.) is equal to (*Lycium barbarum* L.), as they recorded an average concentration of (2.128) for each of them.

Table (5) shows significant differences in total chlorophyll content among the studied plant species. The highest average total chlorophyll content was in the plant (*Achillea santolina* L.), which reached (49.812) mg, significantly different from the rest of the plant species, except for (*Astragalus spinosus* (Forssk) Muchl), which is close to it by a small margin, as it was (49.617) mg. The lowest total chlorophyll content was in plant (*Artemisia herba alba* Asso.), which reached (8.679) mg, and is close to (*Apium graveolens* L.), which reached (9.316) mg (Figure 1).

The reason for the difference in the content of chlorophyll of all kinds may be attributed to the difference in genetic diversity among the studied species, and this is consistent with what was mentioned[9]. Similarly, the age of the plant or leaves affects the chlorophyll content. As the plant and leaves age, the enzymes that break down chlorophyll molecules are activated, thus reducing its level in the plant and consequently decreasing the efficiency of photosynthesis. This was confirmed by[10]. This is consistent with the results of the study we conducted on the (*Apium graveolens* L.) plant, whose leaves live for two years, as it is a biennial herb with a very low chlorophyll content, the lowest among the studied plants, While the (*Astragalus spinosus* (Forssk) Muchl.) plant contains a high level of chlorophyll, the highest among the studied plants, because its leaves grow in the summer and fall in the autumn, meaning they only have one season of life, even though it is a perennial plant.

As mentioned Jin [11] light intensity has a significant effect on chlorophyll content. High light intensity, as in the desert environment, leads to a decrease in chlorophyll content due to light stress. Therefore, we find that some plants have leaves and soft stems with waxy layers and hairs, as well as a small area to reduce bright light rays. Plants need moderate lighting in order to perform all their physiological functions.

Factors affecting chlorophyll content also excessive salinity, which causes a lack of free water around the roots containing nutrients, leading to reduced root and stem elongation and weak leaf growth. This is what it concluded [12]in his research when he treated potato plants with high concentrations of table salt, and this explains one of the reasons that led to the decrease in chlorophyll content in the herbaceous plant (*Apium graveolens* L. ) with short roots and stems.

Hadi Pirasteh- Anosheh [13]concluded that drought has a significant effect on chlorophyll pigment. One of the physiological functions of the plant is that it closes the stomata during drought to preserve the water content, so the entry of carbon dioxide through the stomata is reduced, and the plant's acquisition of nitrogen is reduced, which leads to a decrease in chlorophyll content. This explains what we concluded in this study: that some of the studied plants, such as *Citrullus colocynthis* L., *Lycium barbarum* L., *Apium graveolens* L., and *Artemisia herba alba* Asso., have thick leaves covered with hairs to narrow or close the stomata to maintain water content. Therefore, we find that they have a decrees chlorophyll

concentration than other plants, but it's have

a good water content.

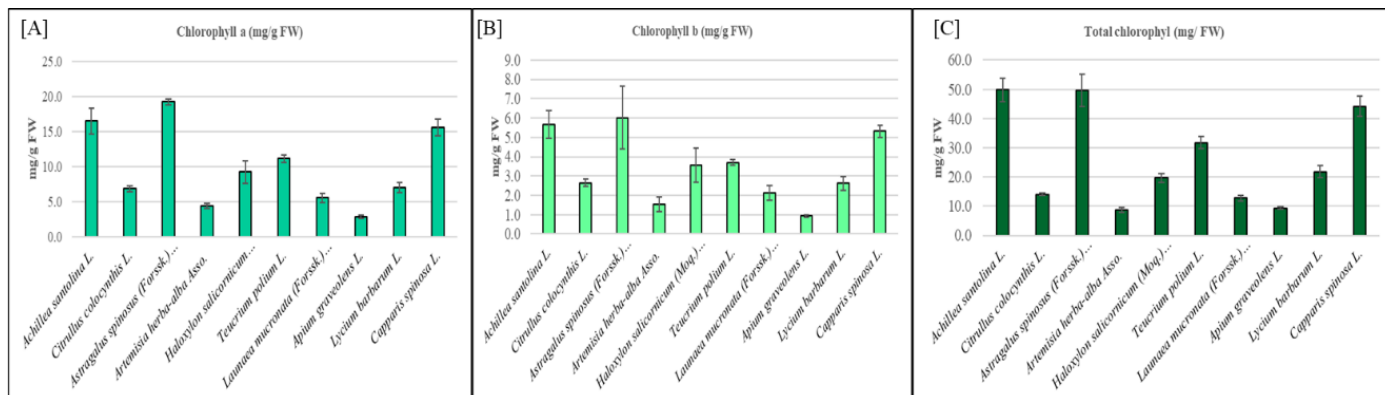


Figure 1. Chlorophyll a, b, Total chlorophyll (mg/100g FW) content

Table 5. Chlorophyll a, b, Total chlorophyll (mg/100g FW) content

Scientific name	Chlorophyll a (mg/100g FW)	Chlorophyll b (mg/100g FW)	Total Chlorophyll (mg/100g FW)
<i>Achillea santolina</i> L.	16.46±1.81	5.66±0.72	49.81±4.0
<i>Citrullus colocynthis</i> L.	6.86±0.40	2.64±0.19	14.09±0.5
<i>Astragalus spinosus</i> (Forssk.) Muschl.	19.21±0.41	6.01±0.19	49.64±5.6
<i>Artemisia herba-alba</i> Asso.	4.42±0.37	1.53±1.62	8.68±0.9
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	9.23±1.61	3.57±0.88	19.65±1.6
<i>Teucrium polium</i> L.	11.11±0.53	3.71±0.14	31.79±2.1
<i>Launaea mucronata</i> (Forssk.) Muschl.	5.52±0.65	2.13±0.36	12.77±1.0
<i>Apium graveolens</i> L.	2.82±0.21	0.93±0.08	9.32±0.4
<i>Lycium barbarum</i> L.	7.00±0.76	2.62±0.35	21.81±2.1
<i>Capparis spinosa</i> L.	15.53±1.20	5.31±0.30	44.18±3.4

Table (5) and Figure (2) show the relative water content of the studied plants, which was calculated by measuring the difference between the fresh weight and dry weight of a known mass of the plant body. The highest percentage of water content was recorded in the plant (*Citrullus colocynthis* L.), reaching 68.7%, followed by plant (*Apium graveolens* L.) at 68.3%, and then (*Lycium barbarum* L.) at 64.7%. The lowest percentage was

recorded in plant (*Astragalus spinosus* (Forssk) Muchl.) at 28.3% and in the plant (*Artemisia herba alba* Asso.) at 29.7%, and it was recorded in (*Achillea santolina* L.) at 42.7%, and (*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.) at 54%, and (*Teucrium polium* L.) at 35%, and (*Launaea mucronate* (Forssk) Muchl.) at 41%, and (*Capparis spinosa* L.) at 42.3%.

Table (5) indicates significant differences in water content percentages among the studied plant species. It shows that the highest relative water content was in (*Citrullus colocynthis L.*) at 68.7%, and the lowest was in (*Astragalus spinosus* (Forssk) Muchl.) at 28.3%, High percentages were observed in (*Apium graveolens L.*) 68.3%, and (*Lycium barbarum L.*) 64.7%, while moderate percentages were found in (*Haloxylon salicornicum* (Moq.) Bunge ex Boiss, *Achillea santolina L.*, *Capparis spinosa L.*, and *Launaea mucronata L.*) at (54%, 42.7%, 42.3%, and 41%, respectively). The percentage decreased in (*Artemisia herba alba* Asso.) 29.7% and (*Teucrium polium L.*) 53%.

The relative water content is linked to the morphological and physiological adaptations of plants and the environmental factors

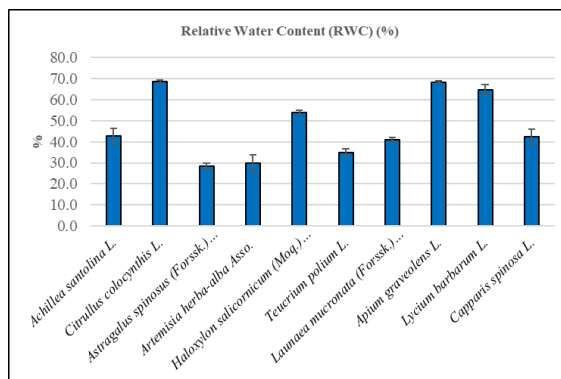
associated with these adaptations. Some plants, such as (*Citrullus colocynthis L.*) and (*Apium graveolens L.*), have good water content, reaching 68.7% and 68.3%, respectively. These plants have adapted their leaves and roots to maintain their water content It has leaves with a thick outer layer and dense hairs that close the stomata and reduce water loss through transpiration. The plant (*Lycium barbarum L.*), although it has small but thick and numerous leaves that cover the entire plant to protect the soft plant body from intense sunlight and reduce transpiration, has a good water content of up to 64.7%, as confirmed by [13]and also[3].

Similarly, desert plants have a root system that enables them to utilize available water; these roots are either shallow and horizontal to utilize rainwater, or deep to utilize groundwater, as mentioned [7]

**Table 5.** Relative Water Content (RWC) (%)

Scientific name	Relative Water Content (RWC) (%)
<i>Achillea santolina L.</i>	42.67±3.79
<i>Citrullus colocynthis L.</i>	68.67±1.53
<i>Astragalus spinosus</i> (Forssk.) Muschl.	28.33±1.53
<i>Artemisia herba-alba</i> Asso.	29.67±4.16
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	54.00±4.00
<i>Teucrium polium L.</i>	35.00±1.73
<i>Launaea mucronata</i> (Forssk.) Muschl.	41.00±3.00
<i>Apium graveolens L.</i>	68.33±2.52
<i>Lycium barbarum L.</i>	64.67±2.52
<i>Capparis spinosa L.</i>	42.33±3.51

**Figure 2.** Relative Water Content (RWC)



## Conclusion

The study results showed that the selected wild plants in the Al-Muthanna desert possess a clear diversity in their morphological characteristics, including leaf shape, size, thickness, and the length of both the shoot and root systems. This reflects their high capacity to adapt to harsh desert environmental conditions. The results also revealed significant variation in physiological traits such as chlorophyll content, efficiency, and relative water content, indicating different physiological mechanisms employed by these plants to cope with water stress and high temperatures. Some species demonstrated a

greater ability to maintain their water balance by reducing water loss and increasing water use efficiency. A correlation was observed between some morphological and physiological traits, indicating the integration of these traits in supporting plant survival in the desert environment. This diversity reflects important environmental and genetic resilience, making desert wild plants a vital resource that can be utilized in genetic improvement programs for drought- and climate-change-resistant plants. The study emphasizes the need to preserve this biodiversity and conduct more in-depth future studies at the genetic and molecular levels.

## References

1. Schaal, B. (2019). *Plants and people : Our shared history and future*. 14–19. <https://doi.org/10.1002/ppp3.12>
2. Shah Aadil Mir, M., Ashraf Bhat, H., Gobindgarh, M., 2023. Adaptations of desert plants to extreme environments. MEDALION J. Med. Res. Nursing, Heal. Midwife Particip. 4, 185–190
3. Mohanta, T.K., Mohanta, Y.K., Kaushik, P., Kumar, J., 2024. Physiology, genomics, and evolutionary aspects of desert plants. J. Adv. Res. 58, 63–78. <https://doi.org/10.1016/j.jare.2023.04.019>
4. Katz, E., Li, J.J., Jaegle, B., Ashkenazy, H., Abrahams, S.R., Bagaza, C., Holden, S., Pires, C.J., Angelovici, R., Kliebenstein, D.J., 2021. Genetic

- variation, environment and demography intersect to shape Arabidopsis defense metabolite variation across Europe. *Elife* 10, 1–25.  
<https://doi.org/10.7554/eLife.67784>
5. Kirschner, G.K., Xiao, T.T., Blilou, I., 2021. Rooting in the desert: A developmental overview on desert plants. *Genes (Basel)*. 12.  
<https://doi.org/10.3390/genes12050709>
  6. Al-Jaberi, M.A.R., 2024. Survey and classification of wild plants in the areas of East Al-Salman (Al-Muthanna Desert). PhD thesis, Coll. Agric. Al-Muthanna Univ. Arab.
  7. Tariq, A., Graciano, C., Sardans, J., Zeng, F., Hughes, A.C., Ahmed, Z., Ullah, A., Ali, S., Gao, Y., Peñuelas, J., 2024. Plant root mechanisms and their effects on carbon and nutrient accumulation in desert ecosystems under changes in land use and climate. *New Phytol.* 242, 916–934.  
<https://doi.org/10.1111/nph.19676>
  8. Nurbolat, S., Guanghui, L., Lamei, J., Lei, Z., 2022. Convergent Variation in the Leaf Traits of Desert Plants in the Ebinur Lake Basin. *Front. Environ. Sci.* 10, 1–12.  
<https://doi.org/10.3389/fenvs.2022.927572>
  9. Abdulhameed, M., Manal, I., Al, Z., Hussein, M., Al-Seadi, L., 2018. effect of atonik and boron applications on some vegetative growth of jujube trees (*Ziziphus mauritiana* Lam.) cv. tufahi 7.
  10. He, X.H., Si, J.H., Zhou, D.M., Wang, C.L., Zhao, C.Y., Jia, B., Qin, J., Zhu, X.L., 2022. Leaf chlorophyll parameters and photosynthetic characteristic variations with stand age in a typical desert species (*Haloxylon ammodendron*). *Front. Plant Sci.* 13, 1–13.  
<https://doi.org/10.3389/fpls.2022.967849>
  11. Jin, C., Zha, T., Bourque, C.P.A., Liu, P., Jia, X., Tian, Y., Li, X., Liu, X., Guo, X., Xu, M., Kang, X., Guo, Z., Wang, N., 2022. Key stress indicators from chlorophyll fluorescence in five desert plant species. *Ecol. Indic.* 145, 109679.  
<https://doi.org/10.1016/j.ecolind.2022.109679>
  12. Hamad, R.O., Massa, R.R., Albiski, F., Almaarri, K., 2025. The effect of salt stress on some morphological and biochemical characteristics of three potato varieties and selected strains from stressed callus. *qscience.com* 6 .  
<https://doi.org/10.5339/ajsr.2025.12>
  13. Hadi Pirasteh- Anosheh, Armin Saed- Moucheshi, Hassan Pakniyat, Mohammad Pessarakli, 2016. Stomatal responses to drought stress. *Water Stress Crop Plants A Sustain. Approach* 1, 24–40.