

RESEARCH PAPER

Utilization of camelthorn (*Alhagi Maurorum*) to produce organic rainfed watermelon for sustainable development in the agricultural sector of arid and semi-arid regions

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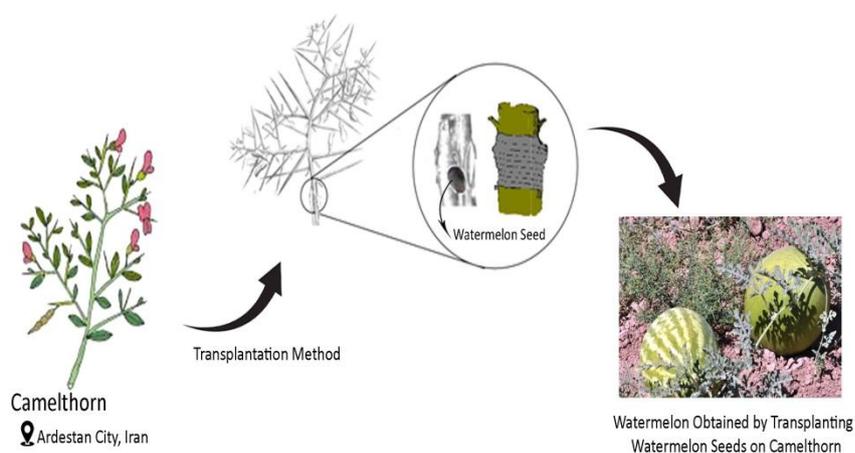
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Highlights

- The use of Camelthorn to produce an organic rainfed watermelon had been common for many years in some provinces of Iran such as Khuzestan.
- The obtained product by the explained method has high quality, sweet and has medicinal properties.
- Based on results, it is time to make contribution to the prosperity of sustainable agriculture by using sustainable and healthy techniques and inputs.
- The awareness of the predecessors can increase productivity and create a sustainable environment for organic products with high nutritional, economical value, and improving the living conditions of local people.

Graphical Abstract



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Abstract

Iran, due to its special geographical location in arid and semi-arid regions, has particular plants and weeds that in general, may be considered worthless and harmful plants. Camelthorn is known as one of these plants. The use of camelthorn to produce an organic rainfed watermelon had been common for many years in some provinces of the country, including Khuzestan, Fars, Yazd, Isfahan and Khorasan. But it has been gradually forgotten due to the introduction of easy access and low price chemical fertilizers and the implementation of government policies to guide local people to plant special crops. In this method, first, an appropriate diameter camelthorn bush is selected, then by scratching a certain part of the stem, watermelon seeds are placed in it; under these conditions, watermelon seeds provide water and other nutrients from the host plant which has deep roots. The results show that the obtained product by the above method has high quality, and despite the perception of some local people, who expected a salty taste for this product, it is sweet and it has medicinal properties. Thus, in the desert, an agricultural product that contains 92% of water can be produced just by using the valuable experiences of the past. Perhaps it is time to make our contribution to the prosperity of sustainable agriculture by using sustainable and healthy techniques and inputs, in the time that the major agricultural products are contaminated with chemical fertilizers and pesticides. The knowledge of the predecessors can increase productivity and create a sustainable environment for organic products with high nutritional and economical value and it can be used to improve the living conditions of local people.

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1. Introduction

Nowadays, the preservation and protection of water resources and the optimal, economical and fair use of water is a global issue, and that is why water is mentioned as a pervasive human challenge in the 21st century (Vanaei et al., 2008; Malmal and Shiri, 2021). The emphasis of the international community is on governments and nations to look at water as a key to development and to consider the available water resources in the watershed as a key element of land management and sustainable development of the watershed (Zare et al., 2011; Benson et al., 2020). Sustainable systems are designed and managed to meet the needs of society, while they maintain ecological, environmental, and hydrological harmony of society at this time and in the future. Limited water resources, increasing water needs, and pollution of existing water have caused human societies to draw a better tomorrow for themselves by using scientific studies, applied research, and planning (Eruyugur et al., 2019; He et al., 2020). Thus, the need for consensus of experts and specialists in the national and international arenas for applied research development in water resources for Iran is essential in line with global developments (Zirgoli and Kahrizi, 2015; Darabpour et al., 2018; Amjadian et al., 2021; Farokhian et al., 2021)

Iran is one of the most unique countries in terms of climate. The temperature difference in winter between the hottest and the coldest points sometimes reaches more than 50 °C. The hottest point of the earth in 2004 and 2005 was somewhere in the Lut desert of Iran (Fig. 1). This country is semi-arid and arid in terms of rainfall (Fallahi, 2017; Ghasemi et al., 2021).

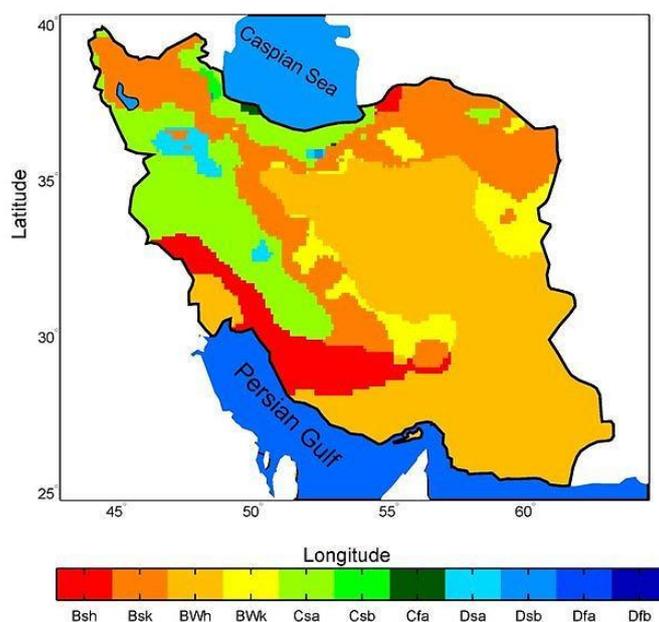


Fig. 1. Climate map of Iran.

Iran, due to its special geographical location in arid and semi-arid regions, has special plants and weeds that in general, may be considered worthless and harmful plants. Camelthorn is known as one of these plants (Lei et al., 2020). The use of camelthorn to produce an organic rainfed watermelon had been common for many years in some provinces of the country, including Khuzestan, Fars, Yazd, Isfahan and Khorasan. But it has been gradually forgotten due to the introduction of easy access and low price chemical fertilizers and the implementation of government policies to guide local people to plant special crops (Zangeneh et al., 2021). According to the sources and studies, in the current situation, the use of indigenous knowledge at this level is not in a good position, so one of those who mention the planting of watermelon and melon on camelthorn is Professor Soltanzadeh, born in 1938 in Yazd. He talks about this type of fruit harvest, which we refer to as an organic product, and says that he saw the way of cultivation by the old Yazdi farmers with his own eyes (Karizaki, 2019; Bakhshi et al., 2021).

But the use of divine gifts of the desert in other ways in some parts of Iran, although insignificant, can still be seen, including the planting of rainfed watermelon in Sonbak pits in the desert region of Sonbak. Sonbak pits are located in the central desert of Iran and about 15 to 20 km² from Bidgol city in the northeast direction. The slope of the land continues from the foothills of the Karkas Mountains to the desert, and the presence of hard layers of land that create groundwater reservoirs near the earth's surface has caused the Sonbak pits area to have groundwater reservoirs close to the surface. Therefore, freshwater is reached by digging a pit 1 to 1.5 meters deep. However, the Sonbak pits are only a few kilometers away from the salt lake where the salt mines are located. From ancient times the farmers have used this feature for planting rainfed. But, due to the presence of abundant desert sands in the area and neglect of their stabilization, with each storm or strong wind, a large amount of quicksand flows into the pits and every year before planting, the quicksand should be shoveled and manually it is very difficult to bring it to the top of the pits. On the other hand, with the advancement of technology and mechanization, along with the abundance of blessings due to the oil sale, and prevalence of laziness, the farmers of Sonbak pits are gradually reduced, unless solutions are considered (Karizaki, 2019).

Previous generations had found that deserts could be cultivated even with abundant quicksand, deadly summer heat, and very low annual rainfall. It was important to discover these resources and used them in ancient times. People of each region knew that they have to produce their food from the same geographical region. Camelthorn (*Alhagi maurorum*) and Syrian mesquite (*Prosopis farcta*) are plants that grow in most of the Iran desert. These plants, because of their strong and long roots, can go down more than 100 meters under the ground (Poudineh et al., 2015; Kazemi and Bezdi, 2021). In the world, organic products have their customers and their price is three times higher than other plant products, which conveys the importance of them. Although European countries have been talking about organic or biological products for several years, the history of Iran shows several thousand years for growing and producing organic products. Those who live in the desert know well how to use its God-given features (Ghobadi et al., 2011; Kotler et al., 2019). Camelthorn and Syrian mesquite roots bring water to the ground from several meters depth and provide water for watermelon and cucumber roots. Farmer has to be so careful only during planting and germinating, and after these steps, the plants do not need farmer attention anymore. Therefore, in the desert, an agricultural product that contains 92% of water can be produced (Poudineh et al., 2015; Kazemi and Bezdi, 2021; Zeidali et al., 2021).

2. Materials and Methods

This field research was conducted in several parts of Iran, including Ardestan city of Isfahan province, Farrokhsahr city of Chaharmahal and Bakhtiari province, and Shushtar city of Khuzestan province from 2008 to 2013. In this study, transplanting of watermelon seeds on a camelthorn base was performed in small areas. Also, the economic, environmental, nutritional and medicinal values of the obtained product were studied and evaluated. We tried to present the reports obtained from these areas, separately. Camelthorn is a perennial plant with a height of 20 to 120 cm and has several thorny branches of green to matte green color. The length of the spines varies from 1 to 6 cm and their angle is almost right. The leaves are oval, 10 to 15 mm long and 3 to 5 mm wide, and the flowers, which usually appear 2 to 8 at the axis of the spines, are purple to dark red. The flower receptacle is hairless and the fruit contains 4 to 7 seeds in the pod. The surface of the pod is smooth or has short spines. There are 12 species of camelthorn in the world, which only two species grow in Iran. The predominant species in Iran is *Alhagi maurorum*, which the botanical description is given above. But another species called *Alhagi graecorum* also grows in the south and southwest of Iran, which is shorter in height, more dense thorns, fully toothed flower receptacle, compact silk hair fruit, and its pod has almost bead shape seeds. This plant was known as *Alhagi manifera*, previously. Also, the dominant camelthorn or *Alhagi maurorum* had more names and synonyms, *A. persarum*, *A. camelorum*, and *A. pseudalhagi*. The Persian name of this plant is Kharshotor (means thorn for camel) and its Arabic name is Alhaji, which the scientific name of the plant, Alhagi, is derived. Also, the word camelorum means camel in Latin (Poudineh et al., 2015; Kazemi and Bezdi, 2021).

Camelthorn root is very deep, strong and wide. It is known as one of the causes of the destruction of ancient buildings. This plant usually grows in deserts, but as a stubborn weed, it spreads rapidly in most farms,

orchards, and lands, and sometimes even splits and removes asphalt. This plant grows up to 400 meters above sea level in the salt marshes of Iran, Saudi Arabia, the Sina desert, Syria, India and Pakistan (He et al., 2020). It is interesting to note that although camelthorn are eaten by camels and goats, and bees are also interested in their flowers, they can only produce manna of *Hedysarum* in certain habitats and the presence and activity of certain insects. Camelthorn nature is very hot and dry according to traditional medicine scholars and they use it as a diuretic and laxative. Also, its decoction is sudorific and rubbing the oil of its leaves is useful for rheumatism. Its flowers are also effective in healing hemorrhoids. Recent research has shown that the substances in camelthorn root can be effective in strengthening the body's defense system and therefore is a good option for the treatment and control of AIDS. Contrary to popular belief and some written contents, camelthorn extract does not affect eliminating kidney and bladder stones. Therefore, according to a study conducted under the supervision of Dr. Iraj Iftikhar Shahroudi, a kidney and urinary tract specialist, the effect of camelthorn extract on the excretion of kidney and bladder stones has not been scientifically confirmed (He et al., 2020).

2.1. Transplantation of watermelon seeds on camelthorn plant in Ardestan city

Ardestan City with an area of 11591 m² and a population of 45150 people is located 118 km² northeast of Isfahan Province. The city consists of 2 counties, 3 townships, 7 countries, and 306 inhabited villages. The center of this city is Ardestan. Ardestan economy is mainly based on agriculture, horticulture, animal husbandry and handicrafts. The area under cultivation of this city is about 15,000 hectares, which is irrigated with 280 deep and semi-deep wells and 500 aqueducts. The agricultural products of this city are pomegranate, cereals and summer vegetables. In the desert and barren areas of this city, camelthorn grows, resists, and remains whereas no plant can survive. Although in this area, camelthorn has a small shrub; It sends its roots to the depths of 10-15 meters under the ground. It uses the least water and moisture and preserves itself (Poudineh et al., 2015; Kazemi and Bezdi, 2021). In Ardestan, camelthorn is cut from the crown and is slotted from its middle and watermelon or melon seeds are placed in it, then it is shut by a thread and is covered by soil and a small amount of water is given as the first water (Karizaki, 2019). This plant penetrates the soil with its 15 meters deep roots, sucks water from the ground and leads to watermelon or melon seeds. The produced watermelon in this region is very sweet and heavy with thick skin (Fig. 2). The color of the inner texture varies from white, yellow to red.

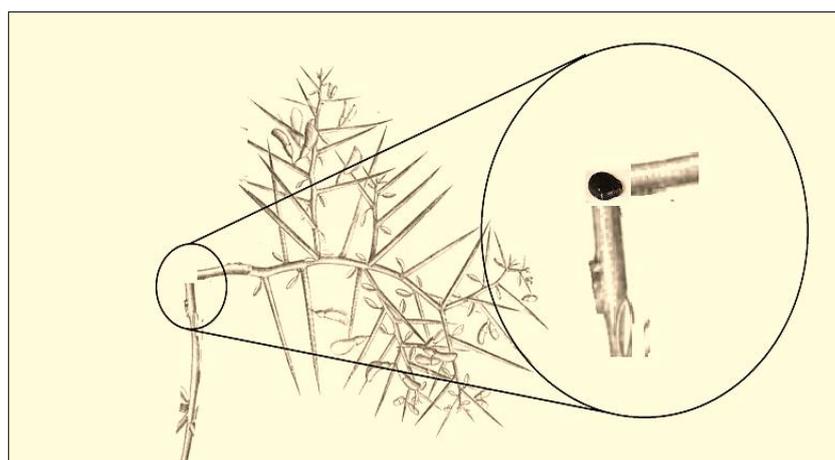


Fig. 2. Transplantation of watermelon seeds on camelthorn by removing the vegetative part of camelthorn plant.

2.2. Transplantation of watermelon seeds on camelthorn plant in Farrokhsahr city

Farrokhsahr is one of the cities of Chaharmahal and Bakhtiari province, which is located on the Shahrekord-Isfahan road. It is the third city of the province in terms of population. The geographical location of Farrokhsahr is located in the northeast of Chaharmahal and Bakhtiari province in the eastern part of the Zagros Mountains at an altitude of 2040 meters above sea level. This city is located 10 km² from Shahrekord and

90 km² from Isfahan. Farrokhsahr is located at 50°58' east longitude and 32°17' north latitude. It is bounded on the north by the mountains of Barat and Panjeh, on the south by the hills of Khairabad, on the west by the agricultural lands of the Ghazdani and Golestan plains, and on the east by the mountains of Baraftab Haji, Rokh and Seh Chah. The Farrokhsahr area is about 300 km². Roughness surrounds the city on three sides and its mountain range is mostly north-south. The highest point around Farrokhsahr is Kuh-e Chaft with an altitude of more than 3100 meters, which is in the south. The lowest point of Farrokhsahr is Ghazdani and Golestan plains, which is located in the west. The soil of this plain has high quality and fertility. Farrokhsahr geological developments, like other areas of Chaharmahal and Bakhtiari, started from the Lower Cretaceous period and in the second period, and its appearance was completed in the third period, and today Farrokhsahr is located on the alluvium of the fourth period (Lei et al., 2020). Planting watermelon seeds next to camelthorn bushes is a special and interesting way with the adjacent transplanting technique, which is mostly used for trees. The method is, after selecting the camelthorn bushes in early April and late May, the bushes that are in good condition in terms of stem diameter are scratched from the top of the crown and the watermelon seeds are placed in the scratch area and a branch is placed next to it and then it is tied with a strong thread. The growth period of this seed is longer than usual, but these watermelons are heavier than Ardestani watermelons and the skin is thicker. In this region, due to the presence of cold and sunlight, the rate of evaporation is more prone and more suitable than similar conditions in Ardestan city (Fig. 3).

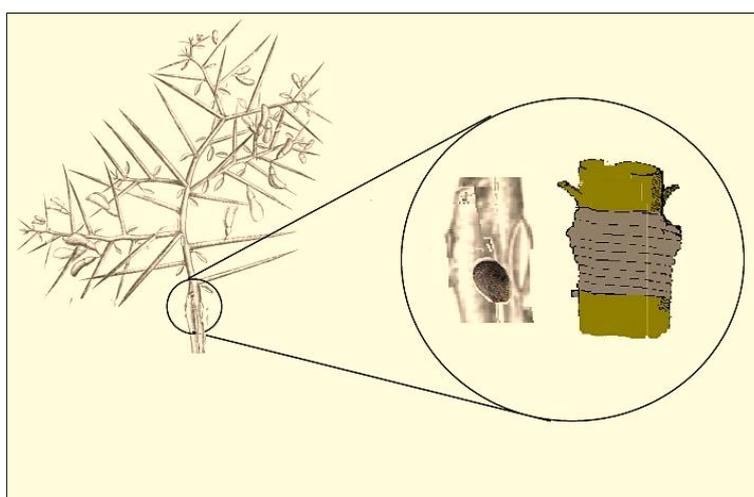


Fig. 3. Transplantation of watermelon seeds on camelthorn plant by adjacent transplantation method.

2.3. Transplantation of watermelon seeds on camelthorn plant in Shushtar city

Shushtar, with 2436 Km² in the north of Khuzestan province of Iran, is located between 48°35' to 49°12' east longitude of the Greenwich meridian and 31°36' to 32°26' north of the equator. Its population is 191000 people (census of 2011) and is the 57th city in Iran and fourth city in Khuzestan province after Ahvaz, Dezful, and Abadan cities in terms of population. Shushtar is located in the center of Khuzestan province and is inclined to the north. Naturally, the final slopes of the Zagros Mountains form the eastern border and the Dez River forms the western border of this city. The average height of Shushtar city is 150 meters above sea level and the height of the central point of Shushtar city is 65 meters above sea level. The mountains overlooking Shushtar are called Fadlak, which are the end of the Zagros folds in the Khuzestan plain. The distance from Shushtar to Ahvaz is 85 km², to Tehran is 831 km² and to the Persian Gulf is 222 km² (Haghshenas and Ghanbari Malidarreh, 2021).

In Khuzestan province, due to the special type of climate with four-season regions, each part of it can be attributed to a climate of Iran, for example, the northern parts have a mountainous climate, the southern parts have a warm climate, and the middle parts have a moderate climate. The history of watermelon cultivation with camelthorn in Shushtar, Susangard, and Ramhormoz cities has been more common than in other cities in Khuzestan province (Fallahi, 2017). The method of transplanting watermelon seeds on the camelthorn plant in

this region is abdominal transplantation (Fig. 4). The natives of this region, same as the natives of Farrokhshahr city, transplanted watermelon on camelthorn after the selection process in the middle and late spring, or sometimes without attention to the season and by examining the condition of camelthorn bushes in the region. The transplanting steps in these areas are as follows: first, a groove is made at the top of the crown and watermelon seeds are placed inside the groove. Then the groove is slightly moistened and the groove is clogged with a spun cloth and a yarn that can hold moisture. Despite the short growth period in this region, the watermelons are smaller than the watermelons of Ardestan and Farrokhshahr, and they have thin skin and an extremely sweet texture (Fig. 5).

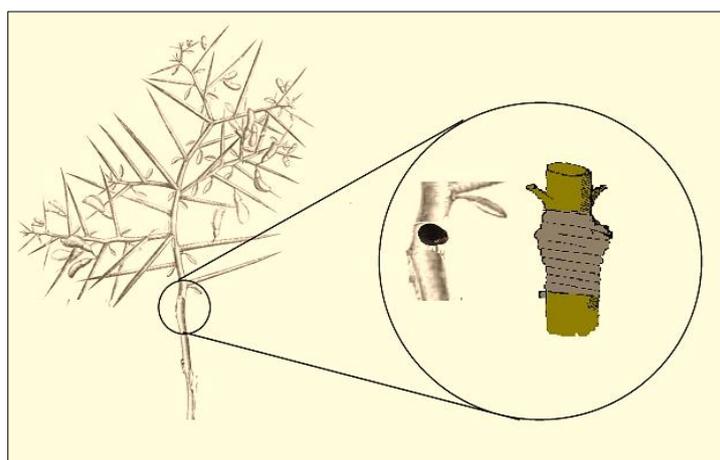


Fig. 4. Transplantation of watermelon seeds on camelthorn plant by abdominal transplantation.

Rainfed watermelon cultivation has been sporadically done by the above method in the pastures of Sepidan city in Fars province until recent years. Local people of this region have planted watermelon seeds by scratching a certain part of some pasturage plants stem. Watermelon seeds get their water and other nutrients from the host and a very good product are produced (He et al., 2020; Modanlo et al., 2021; Rabbani and Safdary, 2021).



Fig. 5. The growth and the flowering of watermelon next to camelthorn in January.

3. Results and Discussion

According to the history of organic agriculture in Iran and the intact natural resources of Iran, it is possible to plan for organic production much faster than industrial and developed countries, because many researchers claim that if chemical products are not used for 3 years, the agriculture ecosystem can return to a sustainable state and provides the full use of natural resources. Due to the growth of a plant called Colocynth (*Citrullus colocynthis*) from Cucurbitaceae that grows in the desert and the harshest climatic conditions, this pattern can be taken from nature that even desert can help to produce organic productions (Fig. 6). Because desert plants, especially camelthorn and Syrian mesquite, grow even on the roofs of houses and airport runways while they are very succulent (Poudineh et al., 2015; Kazemi and Bezdi, 2021; Kazemi and Bezdi, 2021; Poudineh et al., 2015).



Fig. 6. Watermelon obtained by transplanting watermelon seeds on camelthorn.

4. Conclusion

Camelthorn plants with deep roots can be seen in almost all types of soil and areas. To fight against these stubborn weeds, we resort to burning and using different herbicides. But these methods do not work, because the plants have somehow adapted to all conditions. On the other hand, we can use plant tolerance in harsh conditions for being more kind to nature. For example, using camelthorn, which has adapted to any climate, and according to what we have seen and done for years, we can plant watermelon, melon, cucumber or pumpkin next to it. This could be a step, albeit a small one or even at the level of individual consumption, to produce an organic production without the need for water. Thus, in the desert, an agricultural product that contains 92% of water can be produced just by using the valuable experiences of the past. The knowledge of the predecessors can increase productivity and create a sustainable environment for organic products with high nutritional and economical value and it can be used to improve the living conditions of local people.

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