ISSN: 2458-8989

Natural and Engineering Sciences

NESciences, 2025, 10 (1): 446-456 doi: 10.28978/nesciences.1660203

Comparative Morphological Study of Scandix Species Growing Wildly in the Northern Region of Iraq (Iraqi Kurdistan)

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Abstract

Within this study, an optical microscope and a dissecting microscope were used to study the morphological characteristics of species of the genus Scandix from the Apiacece (Umbelliferae). In this study, we were able to separate the three species and give the precise characteristics of each species. The results also showed that the studied species varied in leaf dimensions and the presence or absence of the Involucre, as it was lost in the species S.stellata, while it differed in shape and dimensions between the other two species. As for the flowers, the three species were characterized by their small white flowers located on compound inflorescences, and the species S.stellata was characterized by the presence of hermaphrodite flowers only, while the other two species contain male and female flowers according to their location within the inflorescence. The three species of the genus Scandix have an elongated ovary, with the fertile part in the lower third, while the beak is the upper two-thirds of the ovary and is thinner than the fertile part. The research has proven that these species are protandrous, as the stamens do not develop until late in flowering, and the early appearance of the stamens is compensated for by the stylopodium, which contains nectar glands, as pollen grains stick to its surface until the stamen appears and matures. The fruit in the studied classes is schizocarpae, cremocarp, after ripening the fruit splits lengthwise into two small fruiting units known as mericarp, but it remains connected to the tip of a thin thread known as the carpophore, each fruit contains ridges or edges, the number of which varies according to the species, separated by grooves extending along the length of the fruit.

Keywords:

Apiacece, scandix, morphology.

Article history:

Received: 27/11/2024, Revised: 29/01/2025, Accepted: 21/02/2025, Available online: 31/03/2025

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Introduction

The Umbelliferae (Apiaceae) is one of the most widespread families, especially in the northern temperate regions (Patil et al.,2018). The family includes (200-300) genera and about (3000) species, and in Iraq it has (60) genera and (143) species (Al-Moussawi, 1987). Plants of this family are characterized by special odors due to the presence of secretory cavities with Schizolysigenous channels that contain (resin, aromatic oils, and sticky materials) as they are found in the roots, petals, stems, leaves and fruits (Shokhimardonov et al.,2024; Al-Katib, 1988) Studies have shown the presence of toxic substances in some plants of the family (Rahman & Jaff, 2020). Another study proved that the same plant contains substances used to treat wounds (Rahman et al.,2020).

Scandix is one of the genera of Apiaceae, which was studied within the Iraqi flora by (Townsend et al.,2013) which is S.pectin-veneris, S.iberica, and S.stellata ,The same source also mentioned that the genus is called by several names, including Minqar al-laqlaq, while in Kurdish it is called Kaizhanuk (Vijayakumar et al.,2019).

As for the chemical content of the genus (Demirpolat et al.,2018) stated that (25) chemical compounds were found in the aerial parts and fruits of the species S.pectin-veneris. As for the species S.iberica, (Kaya et al.,2007) stated that its flowers contain (99) compounds of aromatic oils, while the fruits contain (27) compounds of aromatic oils (Inam et al.,2023; Kumar & Sunil, 2024).

The uses of the genus species are numerous, with the genus S.pectin-veneris having the largest share of studies, as some studies have proven that this species has digestive, anti-inflammatory and diuretic properties (Hayek, 2001)Also (Farida et al.,2018) mentioned that the same species is used in Iran to treat blood clotting and palpitations, while the species S.stellata is used as a stomach stimulant (Stanković & Ćurĉić, 2020). As for the species S.iberica, its flowers are used to get rid of Rheumatism (Yeşilada et al.,1993).

Material and Methods

The samples used in the study of morphological characteristics were collected directly from the field during field trips to places that could be reached during two field trips, each trip lasting between (5-10) days, including districts in central and northern Iraq during the spring and summer of 2019. The (Geographical Position System) GPS device was used to determine the coordinates of the areas from which the samples were collected. The identity of the collected samples was fixed, including the characteristics of the samples, the place and date of collection, the type of soil, and the elevation of the area, in addition to determining the lines of longitude and latitude.

A dissecting microscope, Kaisi type, No. KS-37040A, was used to photograph and measure some plant parts, and a compound microscope, MEIJI TECHNO type, No. MT-4300L, was used to study, measure, and photograph the fine plant parts.

Results and Discussion

Habit and Duration: All the studied species of the genus *Scandix* are characterized by being herbaceous, and annual species.

Root: The three species of the genus *Scandix* appear in a light brown color. They are characterized by their short (107.4-68.6) mm، and narrow diameters (1.4-2.7) mm. They have few branches. They grow in loamy, clay and gravel soils.

Stem: The stems of the studied species are characterized as erect, light green in color, thin, Wiry, hollow, with diameters ranging between (0.5-2.9) mm. They are characterized by being grooved or striated, and there are few branches in the lower or middle part of the stem. Table (1) shows the dimensions of the root and stem measured in millimeters.

Stem		Root		species
Diameter	**length**	**diameter**	**length**	
(2.9-0.5) 1.6	(387-85) 217.8	(4.7-0.7) 1.9	(160-82) 107.4	*Scandix pecten-veneris*
(2.8-1.8) 2.2	(390-250) 290	(2.2-1.7) 2.6	(110-45) 75	*Scandix iberica*
(1.9-0.7) 1.2	(220-100) 152.3	(2.2-0.6) 4.4	(85-55) 68.3	*Scandix stellata*

Table 1. shows the dimensions of the root and stem measured in millimeters.

Leaves: All leaves in the three species have short petioles - very short, ranging in length from (6-43) mm as in the species *S.pecten-veneris*, or shorter than that, as in the species *S.iberica* (2-14) mm and (2-10) mm in the species *S.stellata*, and on both sides of the petiole there are elongated membranous sheathes. The leaves are compound bipinnately, triangular in shape - elongated triangle containing slits reaching the midrib Pinnatisect, as shown in Figure (1), in addition to the variation in the dimensions of the leaves within the same plant according to the arrangement of the leaves on the stem, as they are larger in size in the basal leaves (Radical leaves) (47.1- 24.1) mm and smaller in size in the lower cauline leaves (49-29.3) mm, while the upper cauline leaves (23-13.6) mm are the smallest (table 3, 4, 5).

Scandix pecten-veneris Scandix iberica Scandix Stellate

Figure 1. Shows the leaf shapes of Scandix species

Table 2. shows the dimensions of the basal leaves measured in millimeters

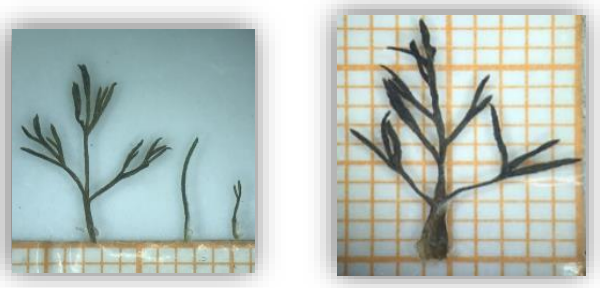
Sheath		Stalk	Blade		Species
Width	**length**	**Length**	**width**	**Length**	
(6-2) 3.5	(17-3) 8.6	(32-4) 15.5	(22-4) 15.5	(83-8) 40.3	*Scandix pecten-veneris*
(4-2) 3.3	(15-3) 9.5	(15-2) 9.7	(30-18) 22.6	(60-40) 52.8	*Scandix iberica*
(3-2.5) 2.8	(16-7) 10.3	(11-8) 10	(27-7) 18.6	(30-13) 21.6	*Scandix stellata*

Table 3. shows the dimensions of the cauline leaves measured in millimeters

Sheath		Stalk	Blade		Species
Width	**length**	**Length**	**width**	**Length**	
(7-2) 4.1	(14-2) 6.2	Sessile	(28-7) 14.6	(50-9) 24.3	*Scandix pecten-veneris*
(4-2) 2.7	(10-4) 6.7	Sessile	(60-10) 25.7	(75-8) 37.6	*Scandix iberica*
(3-1) 2	(12-2) 5.5	Sessile	(15-6) 11.8	(20-12) 14.7	*Scandix stellata*

Table 4. shows the dimensions of the upper cauline leaves measured in millimeters

Sheath		Stalk	Blade		Species
Width	**length**	**Length**	**Width**	**length**	
(13-3) 6.3	(26-2) 10.5	(43-6) 19	(24-4) 24.1	(76-5) 47.1	*Scandix pecten-veneris*
(6-3) 4	(12-5) 9.6	(14-2) 8	(43-22) 29.3	(65-35) 49	*Scandix iberica*
(4-3) 3.5	(15-12) 13.5	(10-2) 6.3	(20-6) 13.6	(24-22) 23	*Scandix stellata*



Scandix pecten-veneris Scandix Iberica

Figure 2. shows the Bracts shapes of Scandix species

Involucel (Bracteoles): It is a group of leaves located inside the compound umbrella inflorescence at the bases of the 2nd rays, at the top of each primary ray. The species *S.pecten-veneris* contains five bracts, green in color, broad lanceolate with one or two slits at the top of the bract leaf towards the base reaching one third of it or may not contain a slit, and it contains thin membranous edges with long spine and is dense in the lower part of the bract, as shown in Figure (3), its average dimensions are (5.4 x 2.5) mm. It can also be observed that the bracts remain not bent downward even in the flowering stages and rarely bend in the fruiting stage, this is consistent with what was stated by (Cohen, 2002; Demirpolat et al.,2019) As for the species *S.iberica* its involucel are similar in shape to the *S.pecten-veneris* involucel, except that they have a number ranging

between (4-7) lanceolate shape, containing a single slit from the tip of the lobed leaf that extends a short distance towards the base, and their average dimensions are (3.2 x 1.5) mm. As for the species *S.stellata* it has single-pinnate leaves with an average dimension (6.6 x 3.4) mm, and their number ranges between (2-5) involucel, with sheath containing dense cilia.

Scandix pecten-veneris Scandix Iberica Scandix stellate

Figure 3. shows the Bractoles shapes of Scandix species

Table 5. shows the dimensions of the bracts and bracteoles measured in millimeters

Bracteoles		**Bracts**		**Species**
Width	**Length**	**Width**	**length**	
(9-1) 2.5	(13-2) 5.4	(9-4) 7.2	(20-7) 13.3	*Scandix pecten-veneris*
(2-1) 1.5	(4-2.5) 3.2	finger-shaped1.5 (3-0.6) single-pinnate4.3 (8-2)	finger-shaped6.8 (16-2) single-pinnate6.6 (10-4)	*Scandix iberica*
(4-3) 3.4	(7.5-6) 6.6	----	----	*Scandix stellata*

Inflorescence: The studied taxa are characterized by having an indeterminate floral system, which is compound umbel inflorescences carried on a peduncle. The studied species differ in the length of the peduncle *S.pecten-veneris* (8-45) mm, the *S.iberica* (3-55) mm, and the *S.stellata* (15-35) mm. A number of radial branches out from the top of the peduncle called first rays (1st rays). Their numbers differ between species, the inflorescences of the *S.pecten-veneris* and *S.stellata* species contain (1-3) primary rays in each inflorescence, while the *S.iberica* has between (5-8) rays in a single inflorescence, this is consistent with what was reported by both (Davis, 1965; Rechinger, 1987)Each ray ends with a group of secondary rays (2nd rays) and this inflorescence is called the secondary umbel inflorescence or partial inflorescence or umbellate, each secondary ray carries one flower.

Flowers: The studied taxa are characterized by their small, Unisexual or bisexual flowers, depending on the location of the flowers in the inflorescence. The *S.stellata* species is characterized by its inflorescences containing only hermaphrodite flowers, and all the flowers are actinomorphic. As for the other two species, their inflorescences contain male flowers that are either separate in special inflorescences within the plant or are found with the hermaphrodite flowers in the same inflorescence. The male flowers in the *S.pecten-veneris* and *S.iberica* are centrally located within the secondary inflorescences. In addition, *S.iberica* is characterized by containing (1-2) male inflorescences, the first inflorescence Peduncle emerges from the top of the Peduncle of the main inflorescence (with the primary rays). As for the second inflorescence, if it exists, its inflorescence Peduncle emerges from the base of the main inflorescence, noting that the male inflorescences have a longer

Peduncle so that they lie above the main inflorescence, as shown in Figure (4) this is consistent with what was stated by (Cohen, 2002). It can be noted that the externally located flowers are zygomorphic, while the central flowers within the same inflorescence are actinomorphic.

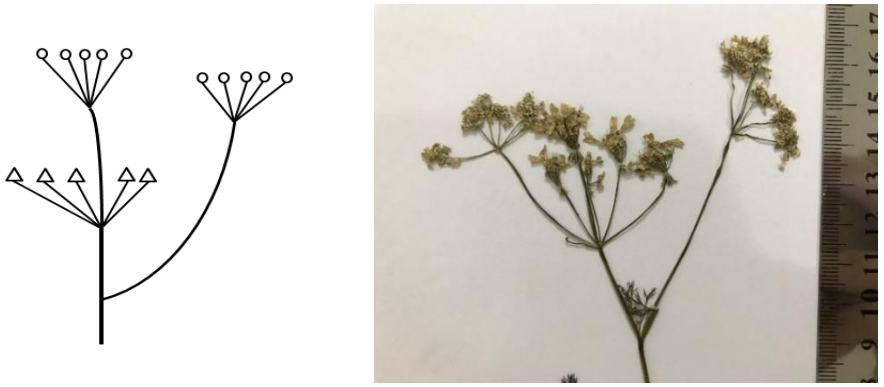


Figure 4. Arrangement of male and hermaphrodite flowers in Scandix iberica inflorescences.

(○) refers to the location of the hermaphrodite flowers in the inflorescence and

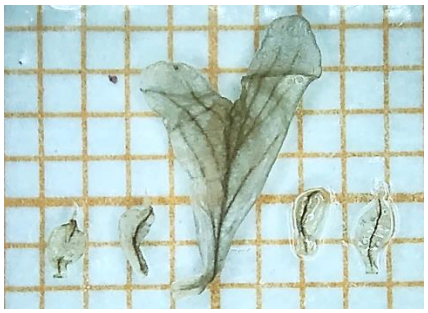
(△) refers to the location of the male flowers in theinflorescence.

The flower consists of the following rings

Calyx: All species of the genus *Scandix* have a missing calyx (Asepalous).

Corolla: The corolla in the studied species is of the polypetalous type, and it is Pentamerous, petals are separate and seated, and arranged in a valvate manner, so the corolla leaves are arranged next to each other without touching, white in color, with a brown midrib. It is of an inverted oval shape and a short caudate apex, as shown in Figure (5), and is of equal size within a single flower in the species *S.stellata*, and its average dimensions (0.8×0.5) mm. *S.pecten-veneris* the petals of the flowers located externally in the secondary inflorescence is slightly larger than the other petals in the same flower. The dimensions of the terminal petal (2.2×0.9) mm, and the dimensions of the other four petals average (1.5×0.6) mm. In *S.iberica* the outer petal is very radial shape and has an incised apex, the incise reaches one-third of the petal, making it appear heart-shaped (Cardate), As for its dimensions, the terminal petal, which is the largest has dimensions (5.9×2.2) mm, while the dimensions of the other four petals average (2.1×0.8) mm. As for the surface covering of the petal leaves in the three species of the same genus, both the ventral and dorsal surfaces contained fine, light brown hairs, more densely on the dorsal surface than the ventral surface. The species *S.stellata* was also distinguished by the presence of fine, few, white spines on both sides of the midrib of the dorsal surface of the petal leaf.

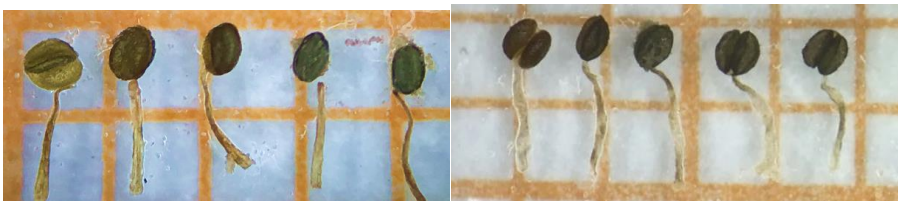
Scandix pecten-veneris Scandix Iberica



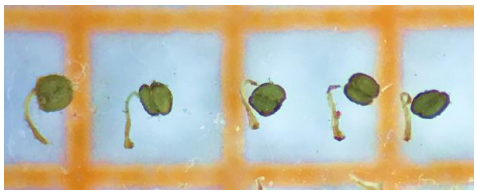
Scandix stellate

Figure 5. shows the petals shapes of Scandix species

Androecium: The male organ in the studied orders consists of five stamens of equal length, fertile, free, polyandrous, and alternating with the petals in a single ring. The filament in all studied species is filiform with an inwardly curved apex, white in color, as shown in Figure (6), and its length varies in the species *S.pecten-veneris* (1-1.6) mm, *S.iberica* (1.2-1.6) mm, and *S.stellate* (0.4-0.7) mm. Anther consists of two lobes and is described accordingly as bilobed, which are fused together longitudinally and completely. The anther is freely attached to the filament on the dorsal side (versatile), and its opening is longitudinal (longitudinal dehiscence) by means of two longitudinal slits on the sides of the anther. The anther free of any appendages, dark green in color, and its dimensions range in the species *S.pecten-veneris* (0.5×0.4) mm, *S.iberica* (0.5×0.4) mm, and *S.stellata* (0.2×0.2) mm.



Scandix pecten-veneris Scandix iberica



Scandix stellate

Figure 6. shows the stamens shapes of Scandix species

Table 6. shows the dimensions of the male organ measured in millimeters.

Anther		filament	
Width	Length	length	Species
(0.5-0.3) 0.4	(0.6-0.4) 0.5	(1.6-1) 1.2	*Scandix pecten-veneris*
(0.5-0.3) 0.4	(0.6-0.4) 0.5	(1.6-1.2) 1.3	*Scandix iberica*
(0.3-0.2) 0.2	(0.3-0.2) 0.2	(0.7-0.4) 0.5	*Scandix stellate*

Gynoecium: The female organ consists of a single pistil with an inferior ovary and two styles, each with a stigma at its apex. The three species of the genus *Scandix* have an elongated ovary, with the fertile part occupying the lower third, while the beak occupies the upper two-thirds of the ovary and is thinner than the fertile part. The ovary is green in color, and the superficial covering is in the form of very short and few spines spread over the dorsal surface of the fertile part and on the sides of the beak in the three species, as shown in Figure (7). The average dimensions of the ovary vary in the three species, being (1.6×0.6) mm in *S.pecten-veneris*, (3.4×0.6) mm in *S.iberica*, and (1.3×0.4) mm in *S.stellata*. Styles are filamentous, greenish-white in *S.pecten-veneris* and *S.iberica*, and range in length from (0.4-1) mm in the former and (1-2) mm in the latter. In *S.stellata* they are green and range in length from (0.2-0.4) mm. It can be noted that the styles in each of the three species are short at the flowering stage and increase in length after the male organs of the flowers mature and continue to increase in length, reaching their maximum length after the fruit matures, this indicates that these species are protandrous and the early appearance of the styles is compensated for by the stylopodium, which contains nectar glands, as pollen grains stick to its surface until the style appears and matures, at which point the stylopodium performs the function of storage as a storehouse for pollen grains, this is consistent with what was stated by (Cohen, 2002; Heywood, 1971) The Stylopodium varies in diameter, color and shape. In the species *S.pecten-veneris* and *S.stellata*, it is slightly disc-shaped, raised by (0.2) mm, and has a dark green-green color with upward grooved edges. In the species *S.iberica*, the Stylopodium is compressed disc-shaped, with upward-grooved edges, resembling a saucer, and is yellowish-green in color with wavy edges. The diameters of the Stylopodium in the three species range between (0.8-1) mm in *S.pecten-veneris* and (0.9-1.3) mm in *S.iberica*, while in *S.stellata* (0.3-0.6) mm. The stigma in the species of the genus *Scandix* is light brown, flat, inclined inward, and its average length in the species *S.pecten-veneris* and *S.stellata* is (0.1) mm, while in the species *S.iberica*, the stigma has an average length of (0.2) mm.

Scandix pecten-veneris Scandix Iberica Scandix stellate

Figure 7. Shows the pistiles shapes of Scandix species

Table 7. Shows the dimensions of the Gynoecium measured in millimeters

Stigma	Stylopodium	Ovary	Ovary		
length	**Diameter**	**length**	**Width**	**length**	**Species**
(0.2-0.1) 0.1	(1-0.8) 0.9	(1-0.4) 0.8	(0.9-0.3) 0.6	(3.3-0.7) 1.6	*Scandix pecten-veneris*
(0.3-0.1) 0.2	(1.3-0.9) 1.1	(2-1) 1.5	(1-0.3) 0.6	(4.3-2.4) 3.4	*Scandix iberica*
(0.2-0.1) 0.1	(0.6-0.3) 0.4	(0.4-0.2) 0.3	(0.4-0.3) 0.4	(1.7- 1) 1.3	*Scandix stellata*

Fruit: The fruit in the studied ranks is Schizocarpae, Cremocarp, originating from a low two-chambered ovary, each containing a single seed that is not separated from the wall of the fruit. The placentation

is hanging type (apical). After ripening, the fruit splits lengthwise into two small fruiting units known as Mericarp, but they remain connected to the top of a thin thread known as the Carpophore. Each fruit contains ridges or edges, the number of which varies according to the species, separated by grooves extending along the length of the fruit. The species of the genus *Scandix* have elongated fruits that can be seen to consist of two parts. The fertile part represents a third of the length of the fruit from the bottom and contains five thin, prominent ribs and is compressed laterally, as shown in Figure (8). As for the upper part, it is the beak, which represents the upper two-thirds of the fruit and does not contain ribs, but is compressed from the dorsal side strongly. As for the color of the fertile part when the fruit at maturity, it is dark brown-black, and the beak is brown in color. The average dimensions of the fertile part are (3.1×1.3) mm, while the beak is (44.5×1.3) mm in the species *S.pecten-veneris*. In the species *S.iberica*, the average dimension of the fertile part is (7.1×1.8) mm, while the beak is (19.2×2) mm. As for the species *S.stellata*, the average dimensions of the fertile part are (2.5×0.6) mm, while the beak is (8.8×0.4) mm. The surface covering varies between the three species in terms of the density and location of the spines. The spines are of medium length and medium density in the species *S.pecten-veneris* and are denser in the species *S.iberica*. The distribution of the spines is similar in the two previous species, as they appear spread over the dorsal and lateral surfaces of the fertile part and are more concentrated on the dorsal surface. As for the beak, there are short spines on its lateral surface. As for the species *S.stellata*, the fertile part of the fruit contains very short spines that are very few and scattered in its lower half and are spread in medium density on the upper half of the fertile part and are more concentrated on its dorsal surface. As for the beak, its surface is covered with very short and dense spines that are denser in its upper half than in its lower half.

Scandix pecten-veneris Scandix Iberica Scandix stellate

Figure 8. Shows the Fruit shapes of Scandix species

Conclusion

This study compared three species of Scandix - S.pecten-veneris, S.iberica, and S.stellata- growing in northern Iraq (Iraqi Kurdistan). The results showed clear differences in their leaves, flowers, and fruits, helping to identify each species.

Leaves: All species have bipinnate leaves, but their size and shape vary. *S.pecten-veneris* has the largest leaves, while *S.stellata* has the smallest (Table 2).

Bracts (Involucre): *S.stellata* lacks bracts, while the other two species have different types of bracts (Figure 2).

Flowers: *S.stellata* has only hermaphrodite flowers, while the other two species have both male and female flowers (Figure 4). The species are protandrous, meaning stamens mature before the stigma to avoid self-pollination.

Fruits: The fruits are elongated. *S.iberica* has the largest fruit, while *S.stellata* has the smallest (Figure 8; Table 7).

Reproductive Structures: The styles, stamens, and ovaries differ in size and shape among species. The stylopodium helps store pollen before the stigma becomes ready (Figures 6 and 7; Table 6).

This study provides useful details to distinguish *Scandix* species based on their shape and structure. Future research should use genetic studies to confirm these differences.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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