



Study of morphological properties and epidermal characteristic in some species of Brassicaceae

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ABSTRACT

These are three species that belong to three different genera within the Brassicaceae family: *Alyssum stapfii* (stapf's alison), *Aethionema carneum* (flesh-coloured stone-cress), and *Barbarea vulgaris* (wintercress or yellow rocket). The aim of this study is to compare the morphology and epidermis of various Brassicaceae species in order to aid in their taxonomic classification. Plant specimens from the Brassicaceae family were collected from the herbarium of the Science College at Salahaddin University. The study involved examining different parts of the plants, including roots, stems, leaves, flowers, fruits, seeds, and stomata. The morphological analysis revealed that the structures of these parts vary significantly among the species. The root length ranges from (4.8 to 7.3) cm, with the shortest observed in *Alyssum stapfii* and the longest in *Barbarea vulgaris*. The width of the roots ranges from (0.28 to 0.5) cm, with the narrowest found in *Aethionema carneum* and the widest in *Barbarea vulgaris*. When comparing the epidermis characteristics among the species, it was found that different types of stomata are present.

Keyword: Brassicaceae roots, Brassicaceae flowers, epidermis of Brassicaceae, morphology of Brassicaceae leaves.

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دراسة الخصائص المظهرية وصفات البشرة في بعض أنواع العائلة الخردلية

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الملخص

تضم عائلة الكرنبات ثلاثة أجناس: *Alyssum stapfii* و *Aethionema carneum* و *Barbarea vulgaris* يهدف هذا البحث إلى مقارنة المظهرية وبشرة عدة أنواع من نباتات الخردلية بهدف استخدامها في التصنيف العلمي. جُمعت عينات من نباتات متنوعة تنتمي إلى عائلة الخردلية من معشبة كلية العلوم بجامعة صلاح الدين. شملت دراسة العينات فحص الجذور والسيقان والأوراق والأزهار والثمار والبذور والتغور. أظهرت الدراسات المظهرية أن بنية الجذور والسيقان والأوراق والأزهار والثمار والبذور والتغور تختلف اختلافاً كبيراً بين الأنواع المختلفة. يتراوح طول الجذر بين 4.8 و 7.3 سم كحد أدنى في *Alyssum stapfii* و كحد أقصى في *Barbarea vulgaris*. يتراوح عرض التغور بين 0.28 و 0.5 سم كحد أدنى في نبات *Aethionema carneum*، وحد أقصى في نبات *Barbarea vulgaris*. وتختلف أنواع التغور بين النباتين.

الكلمات المفتاحية: جذور الفصيلة الصليبية، أزهار الفصيلة الصليبية، بشرة الفصيلة الصليبية، المظهرية أوراق الفصيلة الصليبية.

INTRODUCTION

The morphology datum of plants is distinctly predestined and obtainable, repeatedly they are utilizing in taxonomic studies and the testimony from the external morphology supply the basic language for plant traits, relationships, classification and identification (Radford, 1986). They early plant taxonomist depended almost entirely on morphology to classify the specimens that were sent to them from many parts of the world. As a result of these factors, the classification system among flowering plants generated and subsequent workers were primarily based on morphology data (Stuessy, 1990).

The Brassicaceae; the collection is monophyletic about 338 genera and 3709 species they are found all over the world. It has numerous economically significant decorative and crop species.

The species in this family have blooms with four calyxes, four equal cruciform corollas, six stamens (two short and four long), and two parietal placentae in the ovary, they have capsule fruits with a false septum, it means not actually represent the wall between carpels, called siliqua. Most cruciferous species, including *Brassica oleraceae*, are members of the tribe (Brassicaceae). Brassicaceae is easily identified by its floral and fruiting characteristics. The morphological traits, especially those of the fruit, seed and cotyledons are used to classify the 10 tribes (Mathree and Aliwy, 2024; Gupta, 2012).

Brassicaceae is a large and economically significant family. Commonly referred to as the mustard family, it includes numerous species valued for food, oil, forage, and medicinal purposes. This plant crop is very high in Vitamins A and C, in addition calcium, phosphorus, and iron (Mathree and Aliwy, 2024).

Glucosinolates, a class of metabolites generated from amino acids that contain nitrogen and sulfur, are found in Brassicaceae. The majority of the family's defensive chemicals are glucosinolates. Depending on the particular glucosinolate structure, myrosinases hydrolyze glucosinolates during tissue damage, generating a variety of typically toxic chemicals that function as phytoanticipins. The family also contains a large number of indole phytoalexins. The triterpenoid saponins found in the genus *Barbarea* are one of the various kinds of chemical defenses identified in specific species in addition to these broad crucifer defense systems (Byrne, 2017).

The family is distinguished by its cruciform flowers, composed of four separate petals arranged in a cross-shaped configuration. While the majority of its members are herbaceous annuals or perennials, some species develop a shrubby growth habit (Al-Abide, 2019).

Bolourian and Pakravan (2011) refers to stem morphological characters of *Alyssum contemptum*, *A. marginatum*, *A. strictum* and *A. szovitsianum* in Iran, also (pakravan *et. al.* 2011) studied the fruit characters Iranian *Alyssum minus*. Al-Abide (2022) studied the morphological characteristics of the roots, stems, leaves, fruits and seeds of *Alyssium strigosum* in North of Iraq. while, (Sirin, *et. al.* 2022) reported about *Alyssum strigosum* in Turkey about morphological charechteris, Anatomical and Palynological Features.

Datotek (2022) studied the stem, leaves, flower, fruit and seed morphological characters, anatomical and palynological of *Aethionema lepidioides* in Turkey.

Sirin and Ertugrul (2020) showed the seed macro- and micromorphologies of four taxa (*Barbarea auriculata* Hausskn. ex Bornm. var. *auriculata*, *Barbarea trichopoda* Hausskn. ex Bornm., *Barbarea verna* (Mill.) Asch. and *Barbarea vulgaris* R. Br. subsp. *vulgaris*) in Turkey. Akkemik and Yılma (2016) recorded and studied the root, stem, leave, flower, fruit and seed traits of the new species *Barbarae bracteosa* Guss for flora of Turkey.

Because no work on the stomata and morphology of these genera has been conducted in my country, a comparison among Brassicaceae species is made in this study based on morphological features such as roots, stems, leaves, flowers, seeds, fruits, and stomata.

MATERIALS AND METHODS

1.Morphological study

This study was used Herbarium samples, which taken from the Salahaddin University Herbarium (SUH)/ Erbil/ Iraq and international is (ARB). The work was carried out in the laboratory of Department Biology College of Science - University of Salahaddin. Which used roots, stems, leaves, flowers, seeds and fruits characters based on (Al-Abide, 2019; Guest, 1966; Radford et al., 1974; Rechinger, 1964; Saeed and Saeed, 2021; Simpson, 2006; Stuessy, 1990)

2.Epidermis preparation

The leaf specimens were prepared by removing the outer layer of the leaf. The samples were examined using a light microscope equipped with a camera and analyzed using Image Analysis Software. They were taken and measured the parts of the plants for three replicated for each sample, then taken average of the measurement parts (Fathulla, *et.al.* 2025).

RESULTS AND DISCUSSION

This study shows the Brassicaceae plants are annual, and grow in April and May. The root of all species is taproot (Figure 2). The roots are conical non-branched type except in *A. stapfii* that is branched taproots. The root length arranged between (4.8-7.3) cm (Table 1). The resemblance of root characteristics across the investigated species is likely associated with the common ecological pressures of the mountainous environment, characterized by scarce surface water resources and shallow, rocky substrates. As roots are the primary organs interacting directly with the soil environment, they tend to respond and adapt to environmental variations more rapidly than aboveground plant parts, leading to noticeable morphological changes at an earlier stage (Al-Abide, 2019).

Stem architecture varied among the investigated species and provided useful diagnostic characteristics. *Barbarea vulgaris* exhibited a stem branching pattern originating near the base, whereas *Alyssum stapfii* and *Aethionema carneum* showed branching restricted mainly to the upper portions of the stem. All species possessed erect stems that extended vertically above the ground surface. In addition, its length ranged between (9-25) cm in which the least length was in *Aethionema carneum* species and largest length in *Barbarea vulgaris* specis, the stem diameters in the plants of *A. carneum* and *A. stapfii* recorded the lowest diameters of (0.1 and 0.2) cm, respectively. *A. stapfii* was characterized by slender stems and vegetative organs covered with a

sparse layer of long-rayed stellate trichomes (Figure 1; Table 1). Variations in stem morphology are generally associated with species-specific genetic traits as well as environmental influences, reflecting the adaptive responses of plants to their habitats (Rudall, 1980).

The study of leaves showed that is narrowly elliptic to spatulate-obovate shaped and have petiole as in *A. stapfii*, cauline leaves oblong and amplexicaul as in *A. carneum*. Lower leaves petiolate with cordate ovate-oblong, terminal leaflet, upper cauline leaves amplexicaul in *B. vulgaris*. *A. stapfii* and *A. carneum* were of acute tip and obtus (Figure 3, Table 2), trichome blade, cordate as in *A. stapfii*, smooth blade and cordate base as in other species the basal leaves oblong or ovate in all species except in *A. carneum*, (Al-Abide, 2019) pointed as this study results.

This investigation shows that the flowers are hypogynous. The anthers of Brassicaceae genera consists of six anthers that's connected with filament basified type. The minimum length of the stamen in *A. carneum* (1.5) mm and maximum length in *A. stapfii* (5) mm. The anther in all species (1.5) mm as a minimum length found in *B. vulgaris* and (0.7) mm the maximum length found in *A. carneum*, diameter, the filament sizes varied in length from (1) to (4) mm and in width from (0.2) to (0.5) mm (Figure 4 and Table 4). The ovaries are superior and consists of one carpel; one style and one stigma, the smallest stigma *A. carneum* had a length of (0.2) mm and a width of (0.5) mm. The largest stigma *A. stapfii* had a length of (0.5) mm and a width of (0.2) mm, the style sizes varied in length from (0.5) to (3.5) mm and in width from (0.1) to (0.5) mm, The ovary length from (1) to (2.5) mm and in width from (0.2) to (2) mm (Figure 4 and Table 5). The inflorescences of Brassicaceae family are raceme *Alyssum stapfii* is longer than the other genus (Figure 5 and Table 3).

The present study revealed that all investigated species produced silicula-type fruits; however, considerable interspecific variation was observed in fruit morphology. *Aethionema carneum* was characterized by an upward-curved, cordate fruit with prominent wings, whereas *Alyssum stapfii* produced wingless, ovoid fruits with an acute base. In contrast, *Barbarea vulgaris* developed elongated fruits that differed markedly from those of the other species. Fruit length also varied among taxa, averaging 6 mm in both *A. stapfii* and *A. carneum*, and reaching 27 mm in *B. vulgaris* (Figure 6; Table 6). These observations are generally consistent with the descriptions reported by (Townsend and Guest, 1980).

Seed characteristics likewise exhibited notable variation among the studied species. Seeds were oblong in *A. stapfii* and *A. carneum*, whereas *B. vulgaris* possessed lenticular seeds. Although all seeds were brown in color, differences were detected in their dimensions and surface ornamentation (Figure 6; Table 6). Seed length ranged from 1.0 to 1.1 mm, with the smallest seeds recorded in *A. carneum* and *B. vulgaris* and the largest in *A. stapfii*. Surface sculpturing was distinctly granular in *A. carneum*, weakly granular in *B. vulgaris*, and faintly striate in *A. stapfii*.

Variation was also observed in seed number per fruit, with *B. vulgaris* containing up to six seeds, while *A. stapfii* and *A. carneum* each contained four seeds.

The observed differences in seed morphology, size, and surface patterns represent valuable taxonomic characters that facilitate the discrimination of closely related species. Such traits are considered reliable diagnostic features in systematic studies and support the separation of the investigated taxa. These findings are in accordance with those reported by (Al-Masoud and Al-Shammary, 2017). Despite the variation in fruit and seed characteristics, all studied species shared similar embryo morphology, exhibiting a crescent-shaped structure and a yellowish-brown coloration.

This investigation revealed that the anticlinanal walls of epidermis is straight to slightly undulate, with presence the stomata in both surface (adaxial and abaxial); the stomata adaxial were anomocytic, hemiparacytic and tetracytic, the abaxial were hemiparacytic and anisocytic as in *A. stapfii*. The adaxial and abaxial were paracytic and anomocytic as in *A. carneum*. In *B. vulgaris* the stomata of adaxial were pentacytic, anomocytic and hemiparacytic, while the abaxial is anomocytic (Figure 8).



Figure 1. Herbarium of some studied species of the Brassicaceae famil, A, *Alyssum stapfii*, B, *Aethionema carneum* C, *Barbarea vulgaris*.

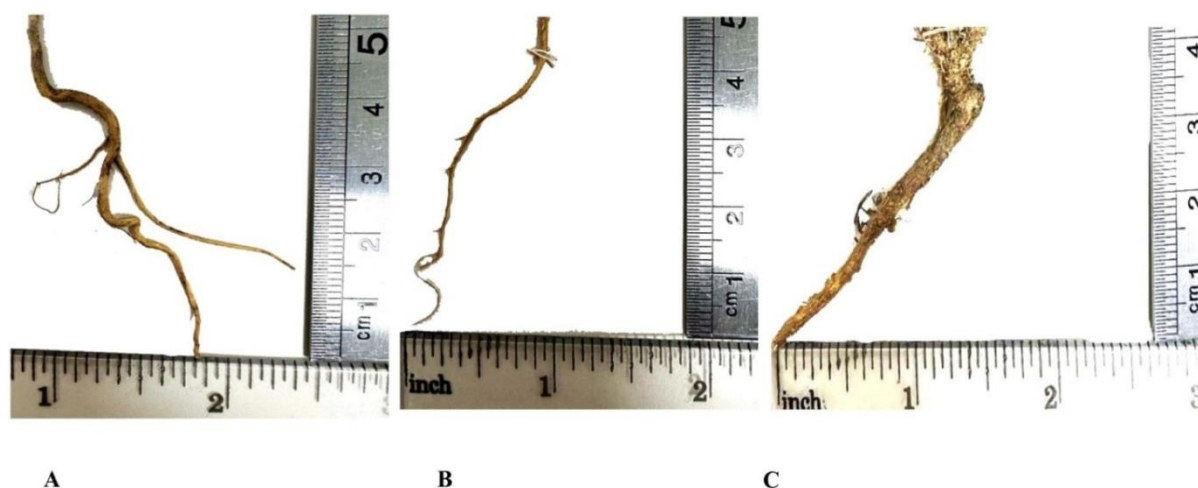


Figure 2. Root shapes of some studied species of the Brassicaceae family, A, *Alyssum stapfii*, B, *Aethionema carneum* C, *Barbarea vulgaris*.

Table 1. Plant habit, root and stem dimensions of some studied species of the Brassicaceae family (cm)

Species	Plant habit		Root		Stem		Shape of stem	Color of stem
	Duration	Plant height	Length	Diameter	Length	Diameter		
<i>Alyssum stapfii</i>	Annual	18.5	4.8	0.3	13.5	0.2	Erect	Green
<i>Aethionema carneum</i>	Annual	16	6.4	0.28	9	0.1	Erect	Dark green
<i>Barbarea vulgaris</i>	Annual	33.5	7.3	0.5	25	0.5	Erect	Green

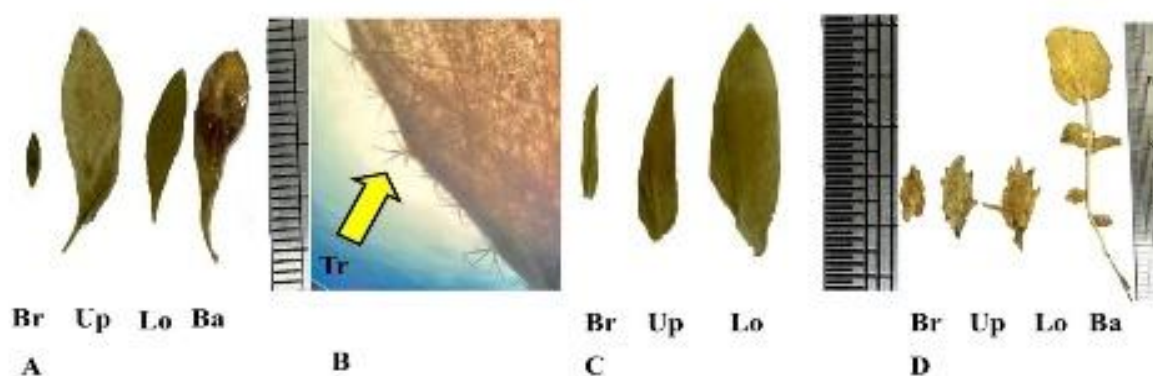


Figure 3. The variation in leaves, and bracts of some studied species of the Brassicaceae family, A, *Alyssum stapfii*, B, Trichome, C, *Aethionema carneum* D, *Barbarea vulgaris*; Ba, Basal leaves; Lo, Lower cauline leaves; Up, Upper cauline leaves; Br, Bract and Tr, trichome

Table 2. Leaves dimension of some studied species of the Brassicaceae family (cm)

Species	Blade Leaves		Basal Leaves		Petiole		Lower Cauline Leaves		Petiole		Upper Cauline Leaves		Petiole		Bract		Color
	L	W	L	W	L	W	L	W	L	W	L	W	L	W	L	W	
<i>Alyssum stapfii</i>	1.6	0.6	1.8	0.7	0.5	0.1	1	0.5	0.2	0.1	2	1	0.5	0.1	0.6	0.25	green
<i>Aethionema carneum</i>	1.6	0.3	----	----	----	----	2.1	0.5	----	----	1.2	0.4	----	----	0.9	0.2	Dark green
<i>Barbarea vulgaris</i>	9.1	2.4	11.8	2.4	1.1	0.2	3.8	2	----	----	3.5	1.5	----	----	2.4	1	Light green

(L): Length, (W): Width

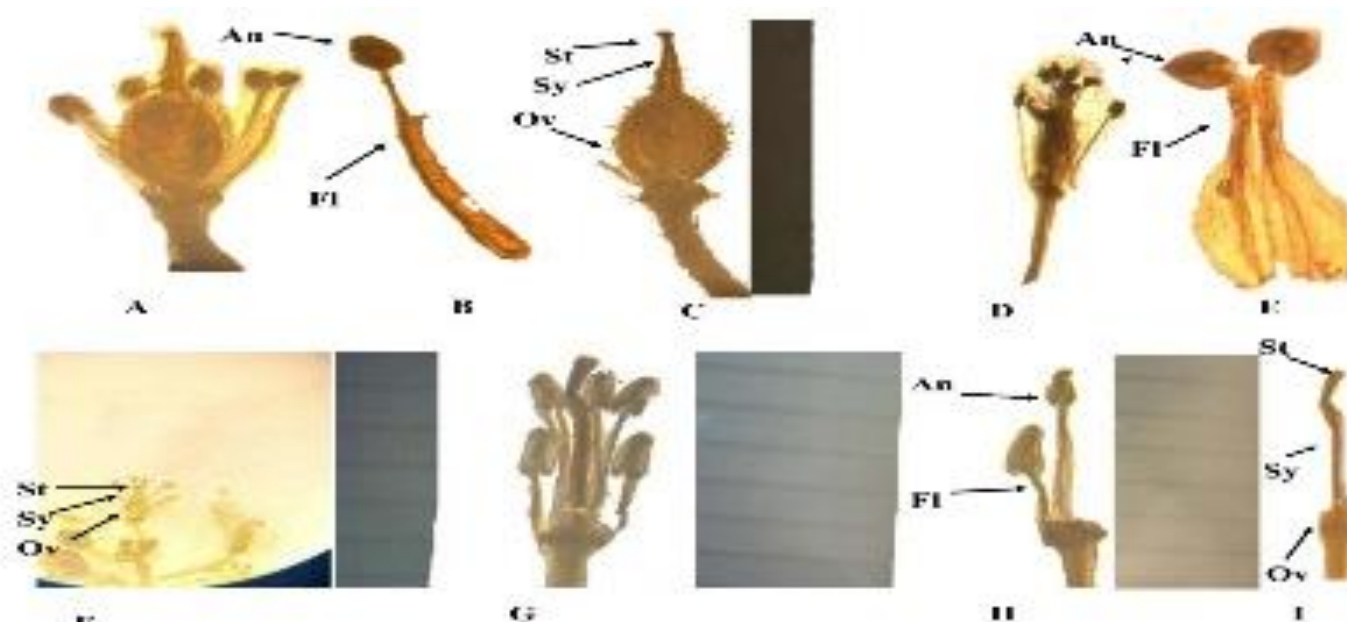


Figure 4. Androecium and Gynoecium dimensions of some studied species of the Brassicaceae family (mm), A, *Alyssum stapfii* D, *Aethionema carneum* and G, *Barbarea vulgaris* B, E and H: Stamen; C, F and I Pistil; An: Anther and Fl: Filament; St: Stigma, Sy: Style, Ov: Ovary.

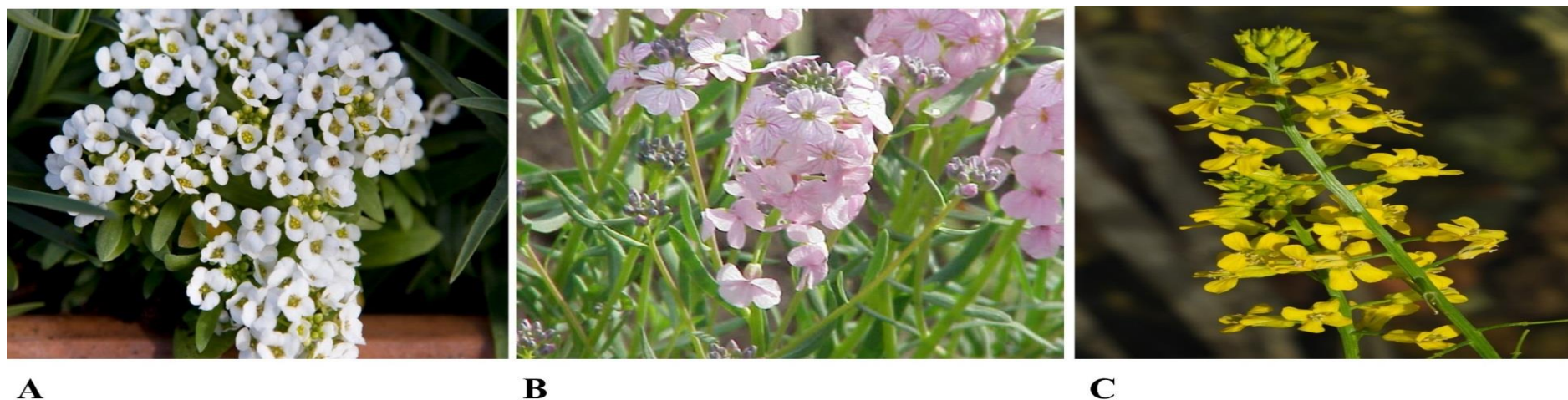


Figure 5. Inflorescence samples of the studied taxa Brassicaceae, A, *Alyssum stapfii*, B, *Aethionemum carneum* C, *Barbarea vulgaris*. BBC Gardeners' World Magazine, 2021. B- Aethionemoideae et. al. 2025, C-Warwick, et.al. 2016.

Table 3. Inflorescence, Calyx and Corolla dimensions of studied some taxa of Brassicaceae (mm)

Species	Inflorescence		Sepal		Petal		Shape	Color
	Length	Width	Length	Width	Length	Width		
<i>Alyssum stapfii</i>	63	21	5	2.1	4	1.2	Oblong-lanceolate	white
<i>Aethionemum carneum</i>	40	20	1.2	0.1	1.5	0.6	infundibular	pink
<i>Barbarea vulgaris</i>	40	20	5	1	5.5	2	infundibular	Yellow

Species	Stamen		Anther	Filament		Color
	Length	Length	Width	Length	Width	
<i>Alyssum stapfii</i>	5	1.1	1	4	0.5	Yellowish-brown
<i>Aethioneum carneum</i>	1.5	0.7	0.5	1	0.2	Brown
<i>Barbarea vulgaris</i>	4.1	1.5	1	3.5	0.5	Light- yellow

Table 4. Androecium dimensions of studied taxa of Brassicaceae (mm)

Table 5. Gynoecium dimensions of studied taxa of Brassicaceae (mm)

Species	Ovary		Style		Stigma		Color
	Length	Width	Length	Width	Length	Width	
<i>Alyssum stapfii</i>	2.5	2	1.7	0.1	0.5	0.2	Brown
<i>Aethioneum carneum</i>	1	0.2	0.5	0.2	0.2	0.5	Yellowish-brown
<i>Barbarea vulgaris</i>	1	1.5	3.5	0.5	0.4	1	Dark Brown

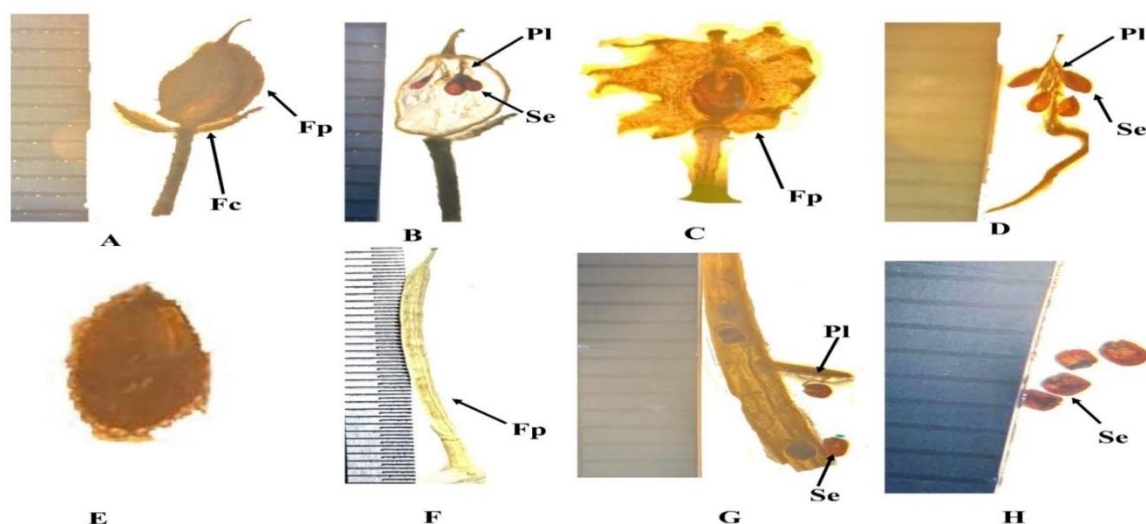


Figure 6. Fruit and Seed Morphology of the studied taxa of Brassicaceae, A, *Alyssum stapfii*, C, *Aethioneum carneum*, F, *Barbarea vulgaris*; A, C, F: Fruiting pod; B, D, E, G, H: Seed; Fp: Fruiting pod; Fc, Fruiting Calyx; Se: seed; Pl: Placenta

Species	Fruiting pedicel		Fruiting Calyx		Fruiting pod		Seed		Placenta		Color
	L	W	L	W	L	W	L	W	L	W	
<i>Alyssum stapfii</i>	5	1	3	1	6	4	1.1	0.8	2	0.5	brownish
<i>Aethionema carneum</i>	3	1	----	----	6	5	1	0.6	1	0.2	Yellow
<i>Barbarae vulgaris</i>	5	2	----	----	27	2	1	0.8	1.1	0.1	Green

Table 6. Fruit and Seed dimensions of some studied species of the Brassicaceae family (mm)

(L): Length, (W): Width

Flowering Period

The present research used data collected from herbarium as well as the data which were recorded on herbarium specimens, to establish the flowering periods of the studied taxa. Which is found that annual species early April to end May. Overall, the study arrived that the date of flowering in the under study taxa is greatly affected by elevation, temperature, moisture, shade, location facing and length of day. Besides the fruiting period, and the morphological appearance in particular the number of branches inflorescence and cymes.

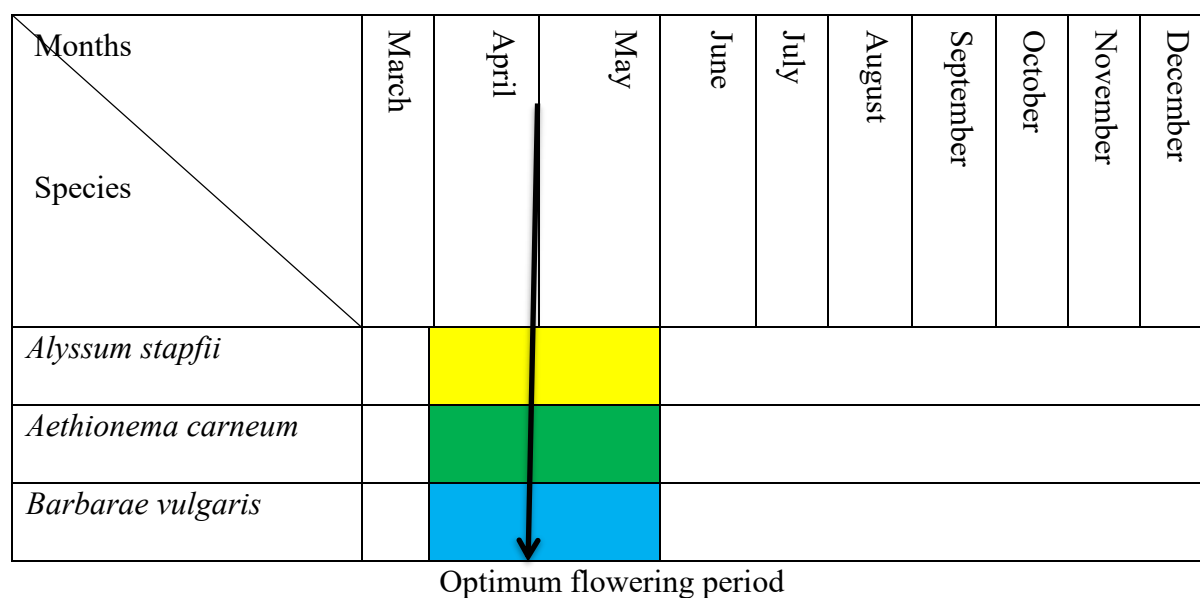


Figure 7. The flowering period of some studied species of the Brassicaceae family.

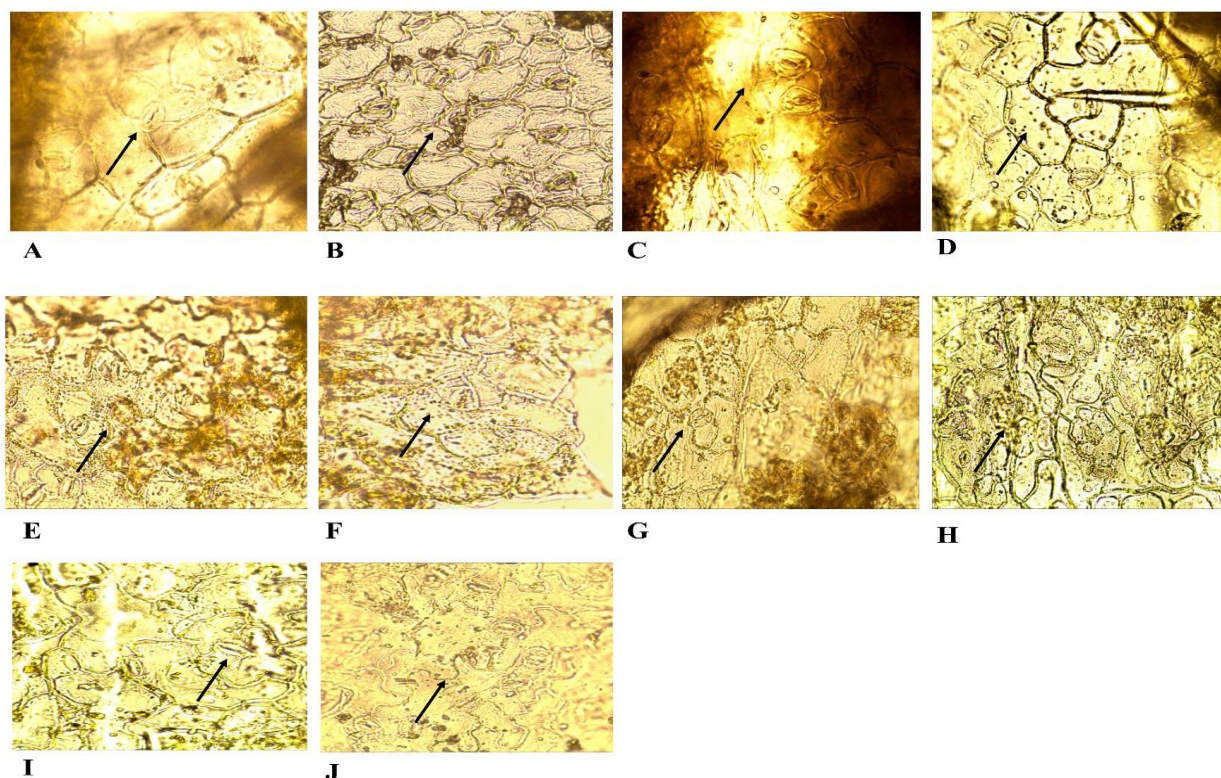


Figure 8. Epidermis of some studied species of the Brassicaceae family, A, B, C, adaxial of *Alyssum stapfii*, D, abaxial of *Alyssum stapfii*; E, F, adaxial of *Aethionema carneum*, G. abaxial of *Aethionema carneum*; H, I, adaxial of *Barbarea vulgaris*, J. abaxial of *Barbarea vulgaris*. Stomata (large black arrow) = J. A, B, C, D, E, F, G, H, I, J =40X

CONCLUSIONS

The findings of this study led to the conclusion that the morphology of the root, stem, leaves, flower, fruit, and seed of various species, such as *A. stapfii*, *A. carneum*, and *B. vulgaris*, demonstrates substantial differences. This conclusion was reached based on the findings of the scientific investigation.

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