

MACRO-MORPHOLOGICAL VARIATION OF ACHENES IN SEVEN SPECIES OF ASTERACEAE FAMILY FROM SEMI-ARID REGIONS OF BARMER, RAJASTHAN

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The present study focuses on a comparative study of achenes in seven species of the family Asteraceae from Semi-arid regions of Barmer, Rajasthan, likely *Acanthospermum hispidum* DC., *Eclipta prostrata* (L.) L., *Erigeron bonariensis* L., *Launaea procumbens* (Roxb.), *Pulicaria angustifolia* DC., *Sonchus oleraceus* L., *Xanthium strumarium* L. Collecting, measuring, describing, and illustrating dried, mature, healthy achenes. The investigation's findings revealed variations in surface, ribs, pappus, shape, size, and colour. The macro-morphological similarities of achenes revealed interspecies relationships and the justifications for their placement in the same family, while the distinctions between them revealed that they are separate species. In order to improve the taxa's systematic position, these characteristics have been utilized. Here is the first description of the macro-morphological studies on achenes.

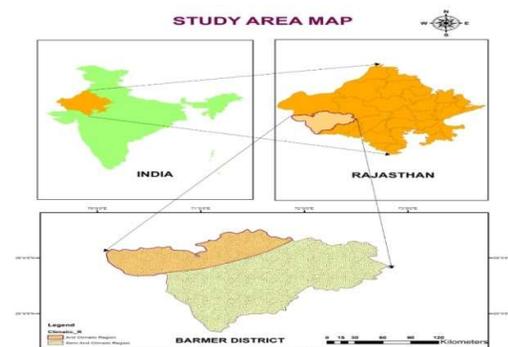
Keywords: Achenes, Asteraceae, Barmer, Macro-morphological, Pappus.

Introduction:

Rajasthan is located in the northwestern part of India, with the largest land area of 3,42,239 km². Prime attractions of Rajasthan are its unique culture, the Thar Desert, great forts, historical places, temples, and flora and fauna. Its western part has one of the major deserts of the world, known as the "Great Indian Thar Desert". Barmer is a district located in the western part of Rajasthan, forming a part of the Thar Desert and having one Desert National Park. Natural vegetation in an arid climate is sparse and consists of perennial and ephemeral plants. The desert area is characterized by xerophytic vegetation and is has a lot of medicinal plants. In the floral study of Rajasthan, it was found that the family Asteraceae of flowering plants has a major contribution to biodiversity. The family Asteraceae includes a great diversity of species, including annuals, perennials, stem succulents, vines, shrubs and trees.

The Asteraceae family spans the entire globe. It is made up of 1,620 genera and 23,600 recognized species¹, which are split into 10 subfamilies and 35 tribes².

Asteraceae exhibit significant morphological variation between and within taxa; one characteristic is the inflorescence, which consists of a capitulum encircled by an involucre comprising one or more sets of phyllaries. Capitula can be single or scapiform, cymose or corymbiform, radiating or disciform to discoid, carrying one type of flower or two types. The fruit is a single-seeded achene³.



The Asteraceae family's fruit, known scientifically as a cypsela or achene, grows from a bicarpellary, syncarpus, epigynous, single-chambered, single-ovuled ovary with basal placentation. Most achenes have pappus, which are modified calyxes according to most current researchers^{4,5}.

The macro and micro-morphological characteristics of the fruit and seed play a vital role in taxonomy, and evolutionary studies have been utilized to identify species⁶.

When the flowering or blooming stage is not available, cypsela or achene characteristics are highly helpful for taxonomic distinction. In the Asteraceae, the pappus is a taxonomically significant and useful organ⁷.

As a taxonomic tool for classification and delimitation of various taxa from species to tribal level in the Asteraceae family achenes diversity in shape, size, pappus, ribbing pattern and surface sculpturing are useful⁸⁻¹³.

Material and Methods:

The present study included achenes of seven species of the family Asteraceae.

Materials of plants were collected from surveyed and selected localities of the study area (Table 1). Various equipment and materials were used for botanical collection as well as laboratory

work. Identification of plant specimens made with the help of "*Flora of Indian desert*"¹⁴⁻¹⁶, "*Flora of Rajasthan*"¹⁷ and "*Flora of Rajasthan South and Southeast Rajasthan*"¹⁸. Preparation of herbarium and documentation of flora according to Bentham and Hooker's system of classification¹⁹. Photographic documentation of these plants was prepared. For achenes morphology, seven species were investigated to record their dimensions, shape, colour, size, surface texture and pappus character using a light microscope and a Sony alpha 6100 camera with a 90mm macro lens.

Results and Discussion:

The main objective of the present research work is the taxonomic study and macro-morphological variation of achenes in the Asteraceae family from Semi-arid regions, Barmer.

During the period of January 2022 to May 2023, the species were collected from different sites of the semi-arid regions of Barmer district.

The morphological characteristics of the species' achenes and pappus are studied and the observations are compiled in Table 2 and Plates 1 and 2. The studied taxa's achenes vary in terms of their shape, colour, symmetry, presence of ribs, and pappus characteristics.

Table 1: Data collection of the studied species of family Asteraceae from Semi-arid regions of Barmer, Rajasthan.

S. No.	Name of species	Habit	Field note	Voucher No.
1.	<i>Acanthospermum hispidum</i> DC.	Herb	Govt. PG college campus	HBSRKGCR02
2.	<i>Eclipta prostrata</i> (L.) L.	Herb	Common at waste land and wet regions, Magra, Barmer	HBSRKGCR08
3.	<i>Erigeron bonariensis</i> L.	Herb	Jasder dham, Barmer agor	HBSRKGCR77
4.	<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajgopal	Herb	QC9F+JWG, Magra, Barmer	HBSRKGCR11
5.	<i>Pulicaria angustifolia</i> DC.	Herb	Common during rainy season in farm fields & grassland areas, Baytu	HBSRKGCR28
6.	<i>Sonchus oleraceus</i> L.	Herb	Common in wasteland, gardens in wet and shaded areas, Barmer agor	HBSRKGCR42
7.	<i>Xanthium strumarium</i> L.	Herb	Haldeshwar mahadev, Siwana	HBSRKGCR71

Acanthospermum hispidum DC.

Local name - unknown

English name - Goat's head, Bristly starbur

Flowering & fruiting - September to December

An herb with spreading hairs that is upright and hispid-pilose. Dichotomously branched stem. Obovate leaves, with an obtuse at the apex, crenate-serrate margins, and crenate at the base, both surfaces having adpressed hairs. Heterogamous single head capitula in a fork of branches. In one series, the female ray florets; tubular, the male disc florets. (Plate 1: a – b)

Achenes are more or less conical in shape, thin at the base and broad at the apex, golden brown in colour, with two long spines at the apex and four short, curved spines between them. The pappus is not present, and the surface is covered with spines. (Plate 2: a – b)

Eclipta prostrata (L.) L.

Local name - Bhringraj

English name - False daisy

Flowering period - September to December

Synonym – *Eclipta alba* (L.) Hassk.

A plant that can be upright, decumbent or prostrate, frequently roots at lower nodes. Stem branches striate, with adpressed, white hairs. Petioles are normally short, and leaves are often oblong-lanceolate or elliptic with both narrowing ends. Inflorescence capitula, axillary, solitary, hemispherical, and upright peduncles. Obtuse, hairy, strigose, and oval involucre bracts. Ray-florets ligulate and disc-florets tubular. (Plate 1: c – d)

Long ovate, winged, brown achenes are their primary characteristics. As opposed to being ridged and tuberculate in texture. Achene bases are truncate in shape. Pappus is either absent or occasionally with very minute teeth on top of achenes cuneate, compressed with a narrow wing, covered with warty excrescences. (Plate 2: c – d)

Erigeron bonariensis L.

Local name - Asthma weed

English Name - Hairy fleabane

Flowering & fruiting – February to April

It is an upright, annual-biennial herb. Ribbed and hairy stem. Head capitula are pyramidal leafy panicles with linear-lanceolate leaves that are constricted at the base. 3-seriate involucre bracts. Pale brown achenes are in colour. (Plate 1: e – f) Achene surface is sparsely haired and has an oblong shape. A deciduous pappus with barbellate bristles that are delicately white, numerous and homomorphic in symmetry. (Plate 2: e – f)

Launaea procumbens (Roxb.) Ramayya & Rajgopal

Local name - Van gobi or Jangligobi

English Name - Creeping Launaea

Flowering & fruiting - October to March

A densely branched and hairless herb, leafless or leaf bearing stem. Oval, oblong, pinnate, runcinate, spinulose or denticulate leaves, with a few that are narrowly oblong, are the most common. Head capitula are cylindrical, with narrow, outer short, inner linear and oblong involucre bracts. (Plate 1: g – h)

The oblong, polymorphous achenes, inner achenes appear to be made up of four, thick ribs, and the outer achenes are slightly bent and flattened. A pappus element completes the apex of the achenes, which has a truncated base. Pappus are deciduous, countless, connate at the base, white, and feature scabrous barbellate bristles of a particular type. (Plate 2: g – h)

Pulicaria angustifolia DC.

Local name - Soneli

English Name - False fleabane

Flowering & fruiting - September to November

It is a glaucous annual herb. The stem is pubescent, terete, subtly striate, and the branches are ascending and divergent. Leaves are sessile, glandularly hairy on both surfaces, linear oblong or obovate in shape, obtuse at the apex, and narrowed at the base. Yellow head capitula with pubescent, slender peduncles, outer involucre bracts that are linear-oblong,

and inner bracts that are scarious and acute with few hairs near the apex. (Plate 1: i – j)

Small, flattened, oblong-obovate, hair-covered achenes have a truncate at the apex and are a dark brown colour. Achenes are shorter than the white coloured pappus. Laciniate cup being formed by pappus. Pappus 2, seriate, with an inner row of barbellate hairs and an outer row of setulose-laciniate cups. (Plate 2: i – j)

Sonchus oleraceus L.

Local name - Aakadiyo, Dudhi

English Name - Sow thistle, Milk thistle

Flowering & fruiting - December to March

An annual herb with glabrous leaves that are sessile, elliptic, oblong, or obovate in shape, runcinate pinnatifid, half amplexicaul with spreading, acute, and dentate on the auricles. Capitula in irregular, umbellate cymes and glandular campanulate pedicles. Yellow flowers with glabrous peduncles and involucre bracts. (Plate 1: k – l)

Achenes are fusiform, brown in colour, and have a tuberculated, ridged structure. The achene base tapered. Pappus is deciduous, myriad, connate at the base, white, and features scabrous barbellate bristles of a particular type. (Plate 2: k – l)

Xanthium strumarium L.

Local name – Chota Gokhru

English Name - Common Cocklebur or Bur weed

Flowering & fruiting - September to December

An annual herb with an erect, stout, sulcate, rough stem and short hairs. Deltoid-ovate, acute, and unevenly coarsely dentate leaves. Racemes of the head capitula are terminal and axillary, with the fertile head axillary and the barren head at the apex. (Plate 1: m – n)

Achenes are 1.2mm long, compressed, glabrous, oblong, and ovoid. (Plate 2: m – n)

According to the kind of capitula, shape of the involucre, types of leaves, types of florets, and variation of achenes, the collected species of this family were

classified and identified.

Characters present in achenes are taxonomically significant at both the generic and species levels, which play a vital role in delimiting a specific evolutionary stage. Additionally, these traits have been used to strengthen taxa's systematic position. In the current study, the macro-morphological characteristics of achenes in seven different Asteraceae taxa exhibit significant differences (Table-2).

In *Acanthospermum hispidum* DC. the surface of the achenes is spiny, demonstrating structural adaptation for efficient animal dispersal. The remaining taxa's achene shapes are oblong, obovate, and oblong-obovate with the exception of *Acanthospermum hispidum* DC.²⁰⁻²¹. Fruit's colour is significant in terms of taxonomy, but it must be fully mature because the colour varies depending on the level of maturity. Three main colours were observed in this study's investigated species, ranging from brown in *Pulicaria angustifolia* DC. to black in *Launaea procumbens* (Roxb.) to bright brown in *Sonchus oleraceus* L. and brown with varying degrees in the remaining species. The four types shapes of achenes found in the investigated species are oblong, oblong-ovate, ovoid to oblong and fusiform; oblong-ovate which is the predominant type.

The achenes may be ridged or not. According to Bhar & Mukharjee and Zareh et al.,^{22, 23} the number of primary and secondary ridges has a significant role in differentiating among the various examined species.

As the pappus micro-characters in the studied species significantly differ from one another, this can be used as additional evidence to support the morphological separation of these closely related species²⁴. Characteristics of pappus for the understudied species include persistence of pappus length, colour, number, and kind. In the current investigation, the pappus were observed scabrous barbellate bristles in *Launaea procumbens* (Roxb.), *Erigeron*

bonariensis L. and *Sonchus oleraceus* L., in *Pulicaria angustifolia* DC. pappus white in colour, unequal with reddish tinge and having laciniate cup, in *Xanthium strumarium* L. pappus are hairy, glandular, scabrous armed with hooked spines, pappus are absent in *Acanthospermum hispidum* DC. and occasionally present in *Eclipta prostrata* (L.) L. Taxonomically, pappus morphological information is helpful for determining relationships among species and has revealed evolutionary relationships within and among genera of Asteraceae^{13, 25-28}.

The morphological characteristics of achenes, such as size, shape, colour, texture, and base, are important traits that can be utilized to identify and distinguish between the associated species. The majority of achene studied species are being studied for the first time in the semi-arid region of Barmer, Rajasthan, so achene morphological characteristics can be very valuable at both the generic and specific level, and their taxonomic value increases when they are taken into consideration in conjunction with other morphological characters.

Table 2: Comparative observations on achenes morphology of the studied taxa of Asteraceae.

S. No.	Characters	Name of Taxa						
		<i>Acanthospermum hispidum</i> DC.	<i>Eclipta prostrata</i> (L.) L.	<i>Erigeron bonariensis</i> L.	<i>Lantana procumbens</i> (Roxb.) Ramayya & Raigopal	<i>Pulicaria angustifolia</i> DC.	<i>Sonchus oleraceus</i> L.	<i>Xanthium strumarium</i> L.
1.	Shape	Conical	Obconical	Oblong	Oblong	Oblong-obovate	Fusiform or basal claviform	Ovoid to oblong
2.	Surface	Cellular, spiny	Glabrous	Sparsely hairy	Winged	Hairy, cellular, cells hexagonal with oblong septa.	Glabrous	Hairy, glandular, scabrous armed with hooked spines
3.	Colour	Golden brown	Pale brown	Pale brown	Black	Blackish brown	Bright brown	Dark brown
4.	Pappus	-	Absent or occasionally with very minute teeth on top of the achenes	Whitish finely, deciduous, barbellate bristles, numerous	Deciduous, numerous, barbellate bristles	White, unequal with reddish tinge, laciniate cup	White, deciduous, numerous	Absent
5.	Ribs	-	-	-	-	-	Present, 3 medium ribs on each surface	-

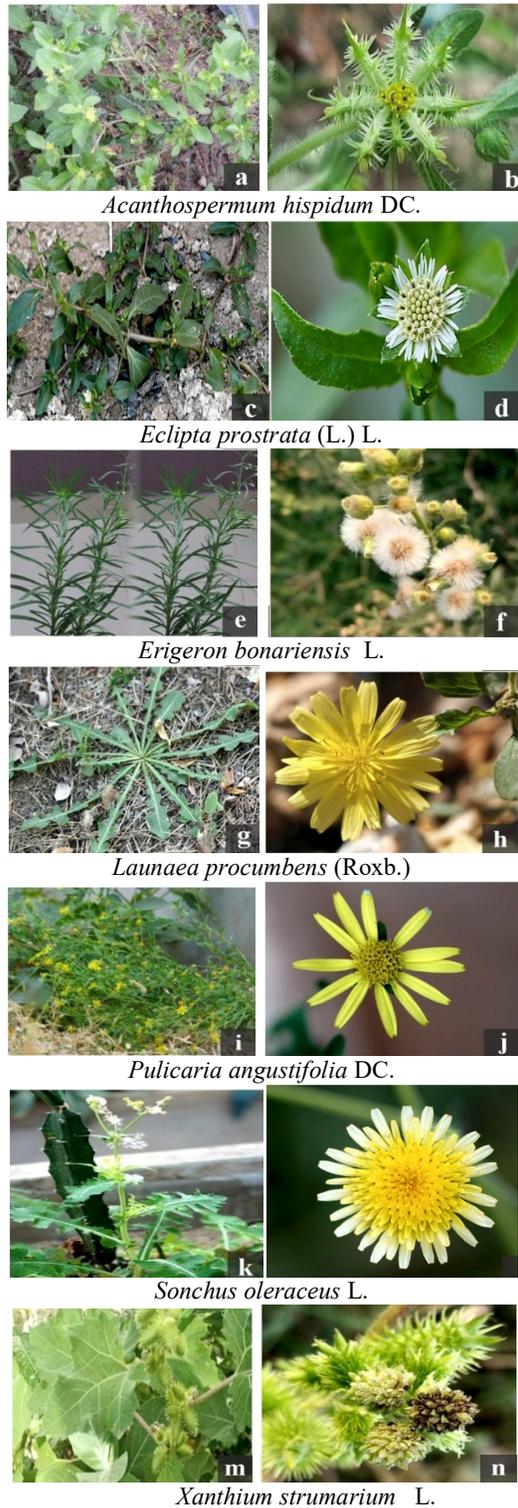


Plate: 1 -Detail studies of collected plant species of family Asteraceae.

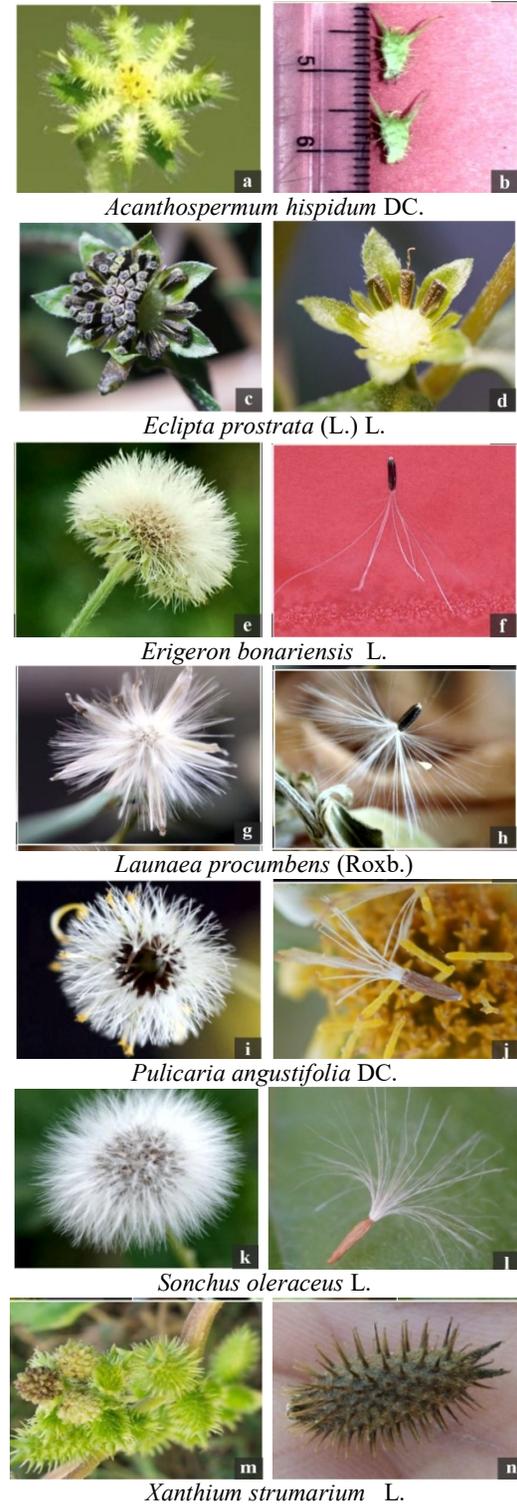


Plate: 2 -Morphology of achenes of studied species from Semi-arid regions of Barmer

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Conflict of interest:

The authors declare that there is no conflict of interest.

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