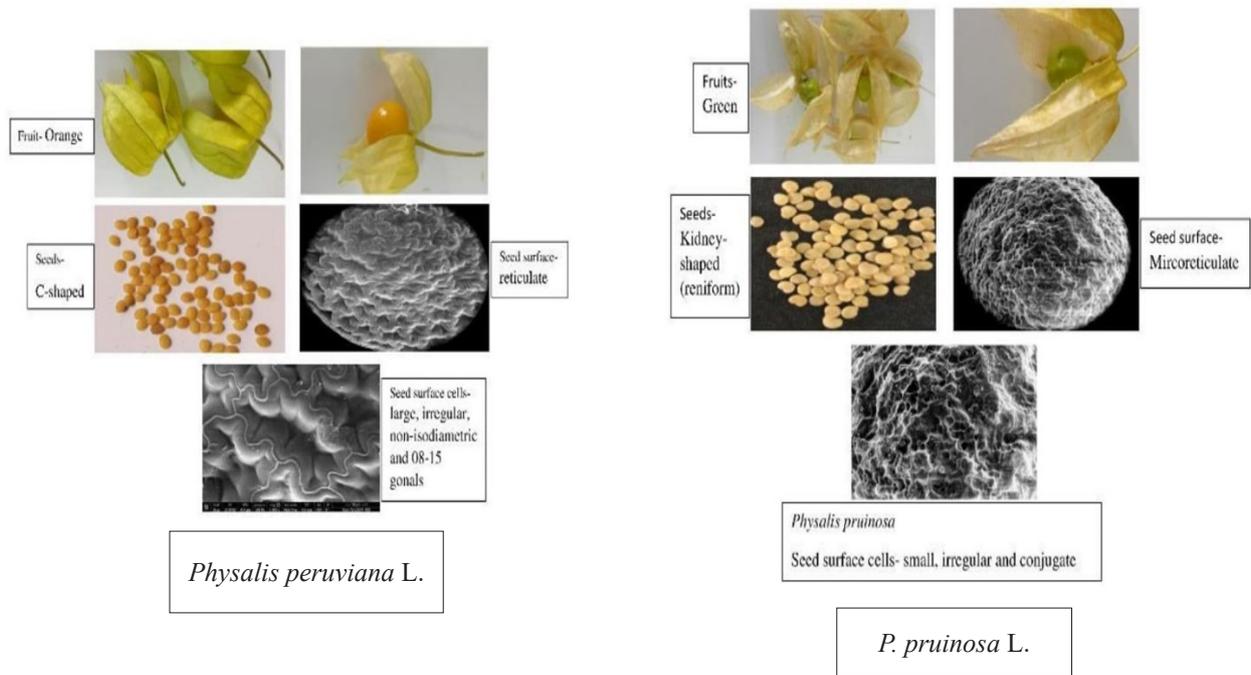


Characterization of two species of *Physalis* L. by using fruit and seed characteristics

A. Kumar and P. Mohil\*



Highlights

- The study contains fruit and seed morphology of two *Physalis* species i.e. *Physalis peruviana* L. and *P. pruinosa* L.
- Major macro and micro seed surface characters were studied.
- Main focus of the study is to find out characters for identification at species level by spermoderm studies.

SHORT COMMUNICATION

## Characterization of two species of *Physalis* L. by using fruit and seed characteristics

A. Kumar and P. Mohil\*

Department of Botany, University of Rajasthan, Jaipur, 302004, India.

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**Abstract:** The fruit and seed characteristic of *Physalis peruviana* L. and *P. pruinosa* L. were studied using fruit and seed colour, and shape along with dimensions and spermoderm pattern. The basic spermoderm sculpture was reticulate and micro-reticulate in *P. peruviana* and *P. pruinosa* respectively. The epidermal cells of *P. peruviana* were large, irregular, non-isodiametric, and 08 - 15 gonals whereas in *P. pruinosa* small, irregular, and conjugate. Anticlinal boundaries of cells in *P. peruviana* observed sinuate, channeled, and thick while in *P. pruinosa* were straight to slightly sinuous and thin. Periclinal cell wall boundaries were observed as highly concave and straight to slightly concave in *P. peruviana* and *P. pruinosa* respectively. The study is useful for identification of both species by seeds.

**Keywords:** Spermoderm; sculpture; reticulate; *Physalis* spp.; Solanaceae.

### INTRODUCTION

The genus *Physalis* L. belongs to family Solanaceae Juss. The family is represented by 88 genera and about 2600 species in the world (Mabberley, 2018). There are 29 Indian genera with 116 species (Kumari, 2004). In Rajasthan, the family represents 7 genera with 23 species along with 15 species in 6 genera that are under cultivation (Shetty and Singh, 1987).

The genus occurs worldwide (Venezuela, Equator, Colombia, Chile, Peru, Australia, New Zealand, and India) and comprises 120 species. There are 8 Indian species of *Physalis* namely *P. alkekengi* L., *P. angulata* L., *P. ixocarpa* Brot. ex Hornem., *P. longifolia* Nutt., *P. minima* L., *P. peruviana* L., *P. virginiana* Mill. (Sharma *et al.*, 2015), and *P. pruinosa* L. (Singh and Pandey, 2002). State Rajasthan represents 4 species among 8 Indian species except for *P. alkekengi*, *P. ixocarpa*, *P. longifolia* and *P. virginiana*. (Shetty and Singh, 1987).

Morphologically the species of *Physalis* are identified by various characters like anther colour, glandular hairs on stem, branches, and leaf margins (Shetty and Singh, 1987). We used the Scanning Electron Microscopy (SEM) technique to examine seed surface characteristics as an additional character for the identification and to differentiate studied species based on the seed surface. In majority colour, shape, and size of seeds, the position

of hilum, the arrangement of spermoderm cells with anticlinal, periclinal cells, and their boundaries, lumen with deposition material are used for SEM analysis.

Lester and Durrands (1984) observed lateral seed coat walls (anticlinal walls of spermoderm cells) in Solanaceae that are thick, more or less pyramidal cells with lignified and elongated projections. Some studies are available on seed morphology emphasizing systematic importance at the generic level of *Physalis* L., *Capsicum* L. and *Tubocapsicum* (Wettst.) Makino (Zhang and Wen, 1996; Zhang and Lu, 1999; Zhang *et al.*, 2005). Scanning Electron Microscopy (SEM) may be used to detect fine features which are taxonomically important (Taia, 2004).

*Physalis peruviana* and *P. pruinosa* were selected for the study of fruit and seed morphology with the main focus on seed surface characters. Spermoderm studies were conducted to find out additional characters for identification.

### MATERIALS AND METHODS

Study material *i.e.* fruits (berries) were collected from natural habitats in the Jaipur districts as well as from the online market (nursurylive.com) and stored in airtight, transparent glass vials. After primary screening and sterilization, selection for storage has been made based on healthiness, uniformity and viability. The authenticity of the online purchased seeds has been confirmed with authenticated plant specimen after growing in a pot. Berries were dissected and biomass *i.e.* seeds and fruit pulps of these were separated using a metal sieve, by passing through tap water. Ten fresh berries and seeds of each species were selected by uniformity in colour, shape, and size. Colour and shape observation was done by hand lens (10×), while the size was measured using a vernier caliper. Seeds were sterilized using ethanol during the sample preparation procedure for SEM analysis. The surface dried, cleaned, and mature seeds were mounted with double-sided adhesive tapes. Two seeds of each sample were coated with gold carefully. Examination and photography were performed with Nova Nano SEM 450 accelerated by a voltage of 15.00 kV. Spermoderm terminology used by Barthlott (1981) was followed in the present study.

\*Corresponding Author's Email: [praveenmohil@gmail.com](mailto:praveenmohil@gmail.com)

 <https://orcid.org/0000-0003-3246-3985>



## RESULTS

### Fruit (berry) characters

Fruit shape, surface, and colour were observed and recorded. The fruit of *P. peruviana* and *P. pruinosa* were berries and enclosed in an inflated calyx. The berries were globose in shape and smooth on the surface. The colour of berries of *P. peruviana* and *P. pruinosa* were orange and green respectively (Table 1 and Figure 1).

### Seed characters

#### Colour and shape

The colour of the seed was yellowish in *P. peruviana* whereas white to straw coloured in *P. pruinosa*. Majority of the seeds were found to be C-shaped in *P. peruviana* and kidney-shaped (reniform) in *P. pruinosa*. (Figure 1 and Table 1).

### Dimensions

The seed measurements in *P. peruviana* were 0.20 to 0.24 mm in length, 0.20 mm in width and 0.08 mm to 0.10 mm in thickness, while 0.20 mm to 0.25 mm in length, 0.18 mm to 0.20 mm in width and 0.10 mm thickness in *P. pruinosa* (Table 1).

### Spermoderm characters

#### Epidermal cells

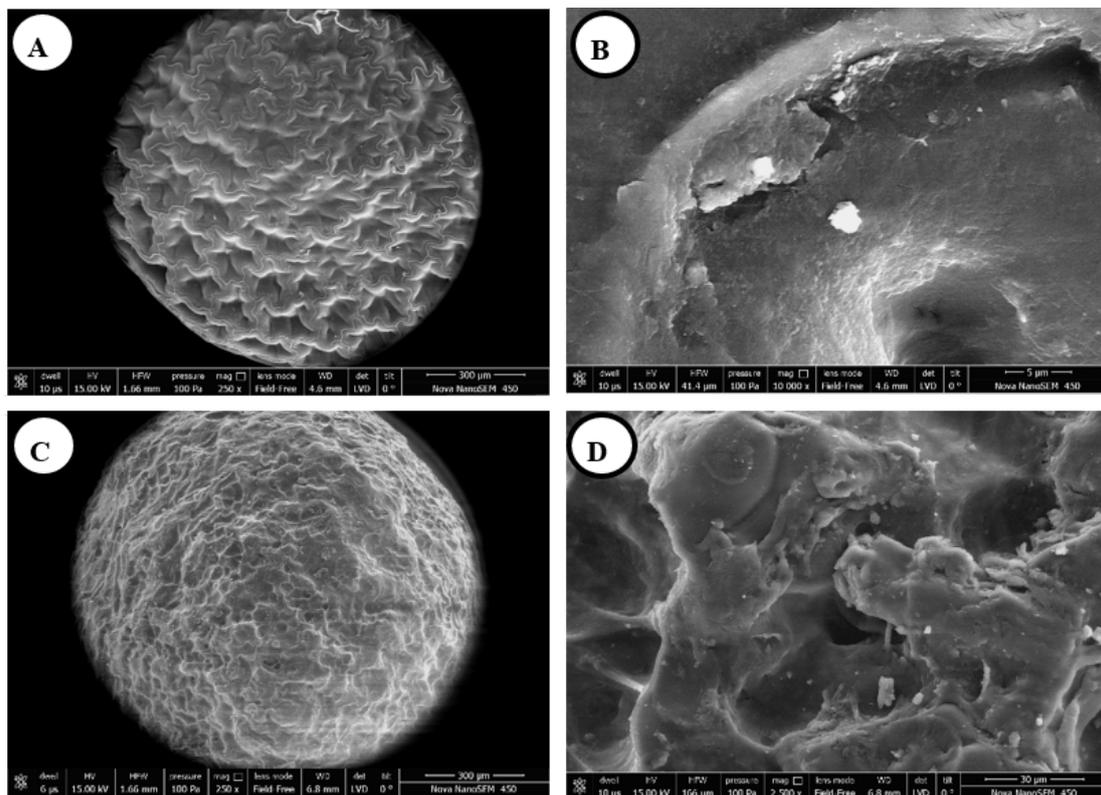
The shape of epidermal cells was different in both the species. In *P. peruviana* cells were polygonal along with 08 - 15 gonals with the moderately thick cell wall, whereas, in *P. pruinosa*, irregular and conjugated cells were present (Table 1 and Figure 2).

**Table 1:** Comparison of seed surface characters of *P. peruviana* and *P. pruinosa*.

Plant species	Berry/Seed	colour	Shape	Size	Seed coat appearance	Epidermal cells	Anticlinal cell walls	Periclinal cell walls
<i>P. peruviana</i>	Berry	Orange	Globose					
	Seed	Yellowish	C-shaped	0.20 to 0.24 mm × 0.20 × 0.08 to 0.1 mm	Reticulate	Large, irregular, and polygonal	Sinuate, channelled	Highly concave
<i>P. pruinosa</i>	Berry	Dirty yellowish	Globose					
	Seed	Whitish to pale yellowish (straw-coloured)	Kidney shaped (Reniform)	0.20 to 0.25 × 0.18 to 0.20 × 0.1 mm	Micro-reticulate	Small, irregular and conjugate	Straight to slightly sinuous	Straight to slightly concave



**Figure 1:** Fruits of *Physalis* species: (A) *P. peruviana* fruits (2750×1547); (B) *P. pruinosa* fruits (2671×1502) (C) *P. peruviana* seeds (1347×1192) and (D) *P. pruinosa* seeds (1894×1512).



**Figure 2:** Scanning electron micrographs of *Physalis* spp. seed: (A) seed surface of *P. peruviana* (x250); (B) cell lumen with cell boundaries of *P. peruviana* (x10000) (C) seed surface of *P. pruinosa* (x250 and (D) cell lumen of *P. pruinosa* (x2500).

#### *Anticlinal cell wall boundaries*

Irregular undulated walls of anticlinal cells (lateral walls) have been observed. Mostly undulation of cells was U-shaped except few cells were being omega-shaped. Anticlinal cell walls of the *P. pruinosa* were straight to slightly sinuous. In *P. peruviana*, the basal portion of the anticlinal testal cell walls was thick, however, it was thin in *P. pruinosa* (Table 1 and Figure 2).

#### *Periclinal cell wall*

The periclinal cell walls of the *P. peruviana* were highly concave with straight to slightly concave in *P. pruinosa* (Table 1 and Figure 2).

## DISCUSSION

Berries with persistent calyx are the fruit type of the family Solanaceae. Due to economically valuable edible fruits, which are rich in vitamin C, *Physalis* is an important plant of this family (Fisher, 2000).

In the seed coat structure of Solanaceae, there are three basic patterns *i.e.* regulate, reticulate, and lavigate. Reticulate seed coat surfaces were observed in *Solanum abutiloides*, *S. diphyllum*, *S. forskalli*, *S. schimperianum*, *S. sinaicum*, and *S. villosum*. Spermoderm cells without conspicuous cell lumen are observed in *S. elaeagnifolium*, *S. lycopersicum*, and *S. nigrum*. (Mehdy *et al.*, 2019). Similarly, we observed reticulate and micro-reticulate seed surface in *P. peruviana* and *P. pruinosa*, respectively.

Irregular, polygonal (5-7 gonal) and large epidermal cells in *Solanum forskalli*, but irregular and conjugate epidermal cells are noted in *S. elaeagnifolium* by Mehdy *et al.* (2019). Along with irregular and polygonal cells, some results of the present work are identical, although the number of gonal (8 - 15) polygonal cells varies. Epidermal cells of *P. peruviana* is irregular, non-isodiametric, polygonal (6 - 14 gonal), and elongate (more in length compare to width). Epidermal cells of the central part of the seed surface are larger than peripheral cells and irregular, non-isodiametric, and conjugate epidermal cells are found in *P. pruinosa*, the result is in agreement with the study of Convolvulaceae analysis by Khalik and Osman (2007).

Khalik *et al.* (2008) observed channelled and straight anticlinal cell wall boundaries in *Galium aparine* whereas *G. setacium* subsp. *decaisnei* have raised and straight to sinuous anticlinal cell wall boundaries. Mehdy *et al.* (2019) found sinuous and straight to slightly sinuous walls of anticlinal cells in *Solanum inacanum* and *S. diphyllum* respectively. The similar result is observed by Khalik and Osman (2007) in some species of Convolvulaceae *i.e.* irregularly, curved or undulated anticlinal cell wall boundaries are observed in *Convolvulus lanatus*, *Evolvulus alsinoides*, *E. nummularius*, and *Ipomea eriocarpa* although straight to slightly sinuous in *Ipomea pes-caprae*, *I. stolonifera*, and *I. carnea*. Our findings are similar *i.e.* thick-walled and undulated boundaries in present *P. peruviana* while in *P. pruinosa* lateral walls are thin and straight to slightly sinuous, but most walls are straight.

In *Solanum virginianum* and *S. elaeagnifolium*, periclinal cell wall boundaries are found to be concave and slightly concave respectively according to Mehdy *et al.* (2019). A similar pattern is observed by Khalik *et al.* (2008) in some *Galium* species e.g. *G. ceratopodum* and *G. nigricans*. Similarly, Khalik and Osman (2007) have observed highly concave in *Convolvulus althaeoides* and *C. fatmensis* while straight to slightly concave in *Convolvulus oleifolius* and *Seddera arabica*. Our findings have shown similar results in *Physalis* species and observed as highly concave periclinal wall boundaries in *P. peruviana* whereas straight-slightly concave in *P. pruinosa*.

## CONCLUSION

*Physalis peruviana* seed measurements were 0.20 mm to 0.24 mm in length, 0.20 mm in width and 0.08 mm to 0.1 mm in thickness, while in *P. pruinosa* length is 0.20 mm to 0.25 mm, width is 0.18 mm to 0.20 mm and is with a thickness of 0.1 mm. The spermoderm pattern of the two species has shown a clear variation. Cells with a moderately thick cell wall were polygonal in *P. peruviana* along with 08 - 15 gonals, while irregular and conjugated in *P. pruinosa*. Cell undulation was U-shaped in the majority. The anticlinal cell walls of *P. pruinosa* were straight to slightly sinuous. The basal portion of the anticlinal testal cell walls in *P. peruviana* was thick while thin in *P. pruinosa*. The periclinal cell walls of the *P. peruviana* were highly concave whereas *P. pruinosa* being straight to slightly concave. Findings of the study are useful for identification of both species by seed characters.

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## DECLARATION OF CONFLICT OF INTEREST

The author declares no competing interest.

## REFERENCES

- Barthlott, W. (1981). Epidermal and seed surface characters of plants: systematic applicability and some evolutionary aspects. *Nordic Journal of Botany* **1**(3): 345-355. DOI: <https://doi.org/10.1111/j.1756-1051.1981.tb00704.x>.
- Fischer, G., Ebert, G. and Ludders, P. (2000). Provitamin a carotenoids, organic acids and ascorbic acid content of cape gooseberry (*Physalis peruviana* L.) ecotypes grown at two tropical altitudes. *II ISHS Conference on Fruit Production in the Tropics and Subtropics* **531**: 263-268. DOI: <https://doi.org/10.17660/ActaHortic.2000.531.43>.
- Khafagi, A.A.F., El-Ghamery, A.A., Ghaly, O.N. and Ragab, O.G. (2018). Fruit and seed morphology of some species of Solanaceae. *Taeckholmia* **38**(1): 123-140. DOI: <https://doi.org/10.21608/TAEC.2018.13520>.
- Khalik, K.A. and Osman, A.K. (2007). Seed morphology of some species of Convolvulaceae from Egypt (Identification of species and systematic significance). *Feddes Repertorium* **118**(1-2): 24-37. DOI: <https://doi.org/10.1002/FEDR.200711123..>
- Khalik, K.A., El-Ghani, M.A. and Kordy, A.E. (2008). Fruit and seed morphology in *Galium* L. (Rubiaceae) and its importance for taxonomic identification. *Acta Botanica Croatica* **67**(1): 1-20. DOI : <https://hrcak.srce.hr/file/35429>.
- Kumari, R. (2004). A Taxonomic Revision of the Indian Solanaceae (Thesis for Ph. D.). Bharathiar University, Botanical Survey of India, Southern Circle, Coimbatore, Tamilnadu, India. DOI : <http://hdl.handle.net/10603/102234>.
- Lester, R.N. and Durrands, P.K. (1984). Enzyme treatment as an aid in the study of seed surface structures of *Solanum* species. *Annals of Botany* **53**(1): 129-131. DOI: <https://doi.org/10.1093/oxfordjournals.aob.a086662>.
- Mabberley, D.J. (2018). *Mabberley's Plant-book: A Portable Dictionary of Plants, Their Classification and Uses* (Eds.). Cambridge University Press, New Delhi. DOI: <https://doi.org/10.1017/9781316335581>.
- Mahdy, M., Hamdy, R., Hasan, L.M. and Bade, A. (2019). Description of seed and pollen micromorphology and their taxonomic impact in some *Solanum* L. species. *Taeckholmia* **39**(1): 1-17. DOI: <https://doi.org/10.21608/TAEC.2019.11353.1003>.
- Sharma, N., Bano, A., Dhaliwal, H.S. and Sharma, V. (2015). Perspectives and possibilities of Indian species of genus *Physalis* L. a comprehensive review. *European Journal of Pharmaceutical and Medical Research* **2**(2): 326-353.
- Shetty, B.V. and Singh, V. (1987). *Flora of Rajasthan Vol. I*. BSI Howrah Calcutta. DOI: <https://bsi.gov.in/page/en/contact-for-publication>.
- Singh, V. and Pandey R.P. (2002). *Physalis maxima* Miller - a new record from India. *Indian Journal of Forestry* **25**(1-2): 187-190.
- Taia, W.K. (2004). Leaf characters within tribe Trifolieae (family Leguminosae). *Pakistan Journal of Biological Sciences* **7**(8): 1463 - 1472. DOI: <https://doi.org/10.3923/PJBS.2004.1463.1472>.
- Zhang, Z.Y. and Wen, J. (1996). Characters of leaf epidermis and seed coats in *Physalis* (Solanaceae) from China and its systematic significance. *Acta Botanica Yunnanica* **18**: 419-423. DOI: <https://doi.org/10.21608/TAEC.2019.11353.1003>.
- Zhang, Z.Y. and Lu, A.M. (1999). A comparative study of *Physalis*, *Capsicum*, and *Tubocapsicum*, three genera of Solanaceae. In: M.H. Nee, D.E. Symon and J.P. Jessop (Eds.), *Solanaceae IV: Advances in Biology and Utilization*, Royal Botanic Gardens, Kew Pp. 81-96. DOI : <https://doi.org/10.2307/25065303>.
- Zhang, Z.Y., Yang, D.Z., Lu, A.M. and Knapp, S. (2005). Seed morphology of tribe Hyoscyameae (Solanaceae). *Taxon* **54**(1): 71-83. DOI: <https://doi.org/10.2307/25065303>.