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Research Article

MORPHOLOGICAL FEATURES FOR CHARACTERIZATION OF LOCAL POPULATIONS OF *Physalis minima* L. (*Ban tipariya*) IN BIHAR

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Abstract- The characterization and identification of different genotypes of a plant is very necessary for its further studies and utilization of plant genetic resources. *Physalis minima* L. or '*ban tipariya*' is an important medicinal and fruit plant of the Indian subcontinent which occurs in many forms in India including Bihar. But it is considered a weed and despite its immense importance, there is not enough knowledge about different genotypes of the plant in Bihar. The present article gives a list of characters, based on literature and careful survey of plant in Bihar, which can be used to identify different genotypes of *ban tipariya* plant, particularly in Bihar. Around 47 characters, 13 measurable and remaining observable, have been considered for scoring variations. The plant showed some variations in many of these characters which were significantly different from standard documented description of the plant. Two types of plants were identified based on height namely dwarf and tall type. Similarly, based on stem morphology two types of plants were identified - pubescent and glabrescent. The plants can also be categorized based on calyx, corolla and fruits into at least four types. The work will facilitate the development of a descriptor for this important plant for not only the plants growing in Bihar, but internationally.

Keywords- *mako*, *P. lagascae,* genotypes, characters

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Introduction

'*Ban tipariya*' or *Physalis minima* L., a close relative of '*mako*', is distributed in various regions of India including Bihar. The plant is found widely in warm temperate and subtropical regions throughout the world [1] including Baluchistan, Afghanistan, Tropical Africa, Singapore, Malaysia and Australia [2]. India is considered its centre of origin. It is an annual or short lived perennial herb belonging to the nightshade family Solanaceae and genus *Physalis.* This genus consists of 80-100 species, most of which are neotropical herbs. The genus gets its name from the Greek word '*Physalis'* which means "a bladder". It is a reference to the inflated, papery calyx characteristic of the members of *Physalis*.

The members of the genus *Physalis* are herbs having axillary yellow flowers that are solitary and cross pollinated [3, 4]. Once pollination has occurred, the corolla drops off and the calyx expands until the developing berry is completely enveloped by a papery husk. The berries range from greenish to yellow to orange and are sometimes flushed with purple or red [4]. Hence the genus is also described by the names "ground tomato" and "husk tomato". *Physalis* species have been taxonomically classified based on characters such as habit, hair type and number of calyx angles [5]. Linnaeus described nine species of *Physalis* in his first edition of *Species Plantarum* of which four species namely *P. flexuosa* (synn. *Withania somnifera*), *P. angulata*, *P. pubescens* and *P. minima* were accredited to India. Later Deb [6] reported occurrence of six species *viz. P. alkekengi* L., *P. angulata* L., *P. ixocarpa* Brot. ex DC., *P. longifolia* Nutt., *P. peruviana* and *P. minima* L. Of these *P. peruviana* (mako) is the cultivated species while *P. minima* is an important medicinal plant which mostly grows as a cosmopolitan weed.

P. minima is a diploid plant characterized by softly pubescent or glabrescent erect stem; petiolate leaves which have entire or toothed margin; hermaphrodite, complete, solitary flowers with clear yellow corolla which is sometimes spotted within; five, epipetalous, 6 to 7 mm long anthers having a black filament and greenish-yellow or bluish white anther lobes. The green fruits are enclosed within enlarged, 10-ribbed, reticulately veined calyx with slender and purplish ribs. But there are many variations to this standard description of the plant and it is difficult to distinguish it from other species. Various synonyms are thus used for this plant namely *P. eggersi* O.E. Schulz, *P. lagascae* Roem. & Schult, *P. divaricata* D. Don and *P. micrantha* Link. Most of the Indian taxonomic literature describes two types of plant under *P. minima* L. The first one is an erect, robust, smooth, tetraploid taxon with bigger flowers (>7 mm across), bluish anthers and fruiting calyces tinged purple while the second one is a diffuse to erect, relatively smaller, pubescent, diploid taxon with smaller (<6 mm across) flowers, yellow anthers, and greenish fruiting calyces. The former description is more close to *P.angulata* L. while latter corresponds to *P. lagascae* Roem. & Schult [6]. Nonetheless, both these descriptions are accepted by workers as *P. minima* if the plant is diploid since there is no elaborate account of the different genotypes of the plant occurring in India particularly Bihar. Also due to continuous natural hybridization, various new forms of the plant are arising, but there is no recent account to describe them. The most recent description of the plant in Bihar comes from Flora of Bhagalpur [8] which describes two types of plant: *P. minima* L. and *P. minima*. L. var *indica*. Both these types are weeds growing in fields and gardens. Both have similar characters except that *P. minima* L. var *indica* is a glabrescent plant with clear yellow corolla while *P. minima* is a pubescent plant having yellow

corolla with purple eye. Thus, there is a need to have a list of characters which aid in identification of different genotypes of the plant in Bihar.

Materials and Methods

The list of characters in this article were based on literature and careful observation of different populations of the plant in various districts of Bihar. Various morphological characters *viz.* habit; plant height; stem morphology; leaf color, venation; calyx and corolla; anther color; fruits and others were evaluated for scoring variations. Around 47 characters have been described, out of which 13 are measurable characters and remaining are observable. All these characters were observed at full foliage stage of the plant. The observations were recorded for at least 10 randomly chosen plants of each population. The characteristics of fully mature leaves and flowers which were at their full bloom were observed. The fully mature unripe and ripe fruits were observed for recording variations in fruit characteristics. . Each observation was recorded for five randomly chosen leaves, flowers or fruits of each plant. These characters can be used to identify different genotypes of the *ban tipariya* plants.

Results

The following characters were observed for identifying different genotypes of *ban tipariya* plants in Bihar.

1. Habit

The *P. minima* plants were herbs.

2. Height

Height of the plant in centimeter was recorded. The height was in the range of 50 cm to 150 cm. Two types of plants were identified: tall with a height in the range of 80 cm-150 cm and dwarf in the range of 50 cm-80 cm [Fig-1].

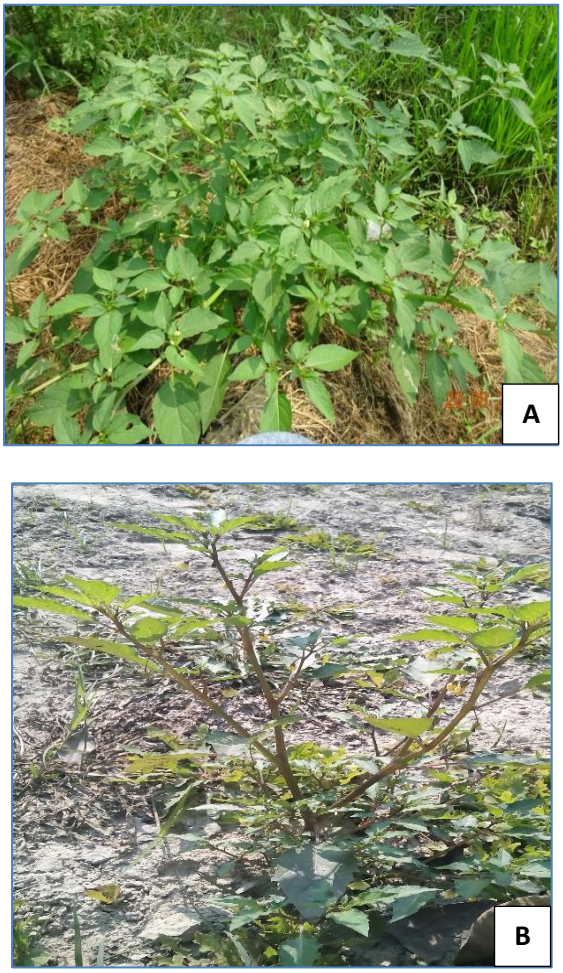


Fig-1 Habit of plant based on height: A- Dwarf type; B- Tall type

3. Stem

The distinguishing features of the stem were:

3.1 **Appearance**: *Ban tipariya* plants were either glabrescent or pubescent [Fig-2]. In Bihar the most common type is the glabrescent type.

3.2 **Colour**: The stem of the plant was generally green in colour. Some plants had a purple tinged stem.

3.3 **Hairy**: The glabrescent plants were smooth while pubescent plants had minute hairs on their stems.

3.4 **Branching**: The *P. minima* plant was dichotomously branched at full maturity.

3.5 **Number of branches**: The number of branches depended on the height of the plant. The dwarf plant had more profused branching (30-35 branches per plant) while tall type had comparatively less number of branches (10-15 per plant) [Fig-1].

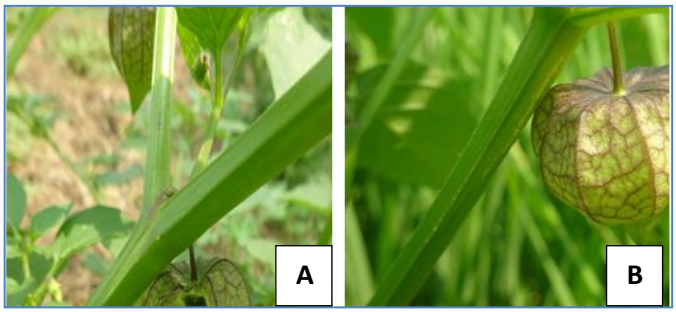


Fig-2 Stem type: A- Pubescent B- Glabrescent

4. Leaves

The leaves were petiolate, exstipulate and ovate to chordate. Each observation was recorded for five leaves per plant and average was considered. The identifying features were:

4.1 **Margin**: The leaves of *P. minima* had three types of margin [Fig-3] :

i. Entire
ii. Shallowly toothed
iii. Toothed

4.2 **Shape of apex**: Most of the leaves had an acute apex.

4.3 **Venation**: The leaves had a reticulate palmate venation.

4.4 **Colour:** The leaves were either dark green or light green. In most of the plants both dorsal and ventral surfaces had same colour while in some plants dorsal surface was dark green and ventral surface was light green.

4.5 **Length:** The length in centimeters was measured from tip of leaf to the base of leaf. The leaves of *P. minima* were 4-11 cm long when fully mature.

4.6 **Breadth:** The breadth was measured in centimeters. The widest portion of the leaf was taken into account. The leaves of this plant were 2-6 cm wide when fully mature.

5. **Inflorescence**

The *P.minima* plant bore solitary flowers which were pedicellate, hermaphrodite, complete and small campanulate. Pedicels were about 20-25 mm long and flowers were 1.2 to 1.4 cm in diameter.

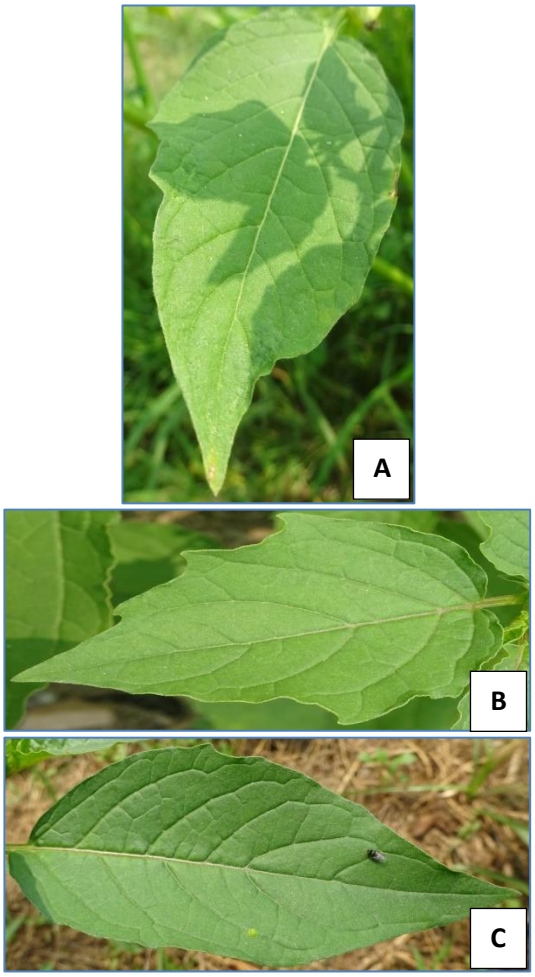


Fig-3 Types of leaf margin: A- Shallowly toothed; B- Toothed; C- Entire

6. Calyx

The calyx in *ban tipariya* was persistent and actinomorphic, 3-6 mm long. It had following distinctive features:

6.1 Colour: The calyx in all plants was green in colour.

6.2 Number of sepals: The calyx in *P. minima* was gamosepalous in which five sepals were fused to form a cup. The calyx lobes were acute and triangular.

6.3 C**olour at base**: Some plants had a purple spot at base of green calyx while others lacked this feature.

6.4 Calyx venation: All plants had reticulately veined calyx. The plants differed in the colour of primary and secondary veins.

6.5 Number of veins: The calyx had ten toothed primary veins and many secondary veins.

6.6 Colour of primary veins: The ten primary veins were either purple or green in colour but mostly they were purple.

6.7 Colour of secondary veins: The secondary veins in some plants were green while in others were purple.

7. Corolla

The observations were recorded similar to calyx.

7.1 **Colour**: The flowers were either light yellow or yellow in colour. Sometimes greenish yellow flowers were also found.

7.2 **Number of petals**: The plants had five petals which were fused to form a cup. The corolla was 1.2 cm X 1.2 cm in size and corolla cup was 1.1 to 1.3 cm long.

7.3 **Spot at base**: The cup shaped corolla showed a distinctive pattern at the base within. The base was either clear without any spot or had dark yellow or brown spot. Sometimes black spots were also present on yellow background. The spots were visible only in fully mature flowers [Fig-4].

Fig-4 Corolla types: A – Corolla clear yellow; B – Corolla with dark yellow spot; C- Corolla with brown spot

8. Stamen

The epipetalous anthers were 1-2 mm long with 6-7 mm long black or purple filament. The filaments were attached close to the base of the corolla tube. The

plants had five anthers which had either white or bluish white or creamish anther lobes. Sometimes greenish-yellow anther lobes were also present [Fig-5].

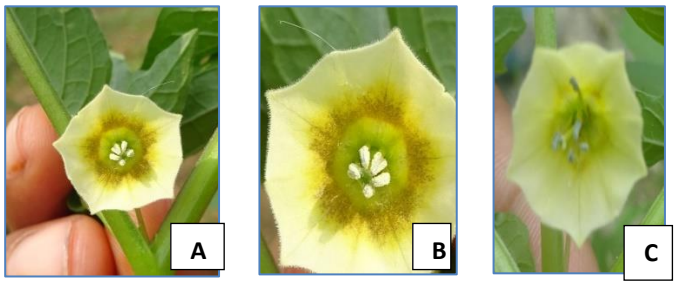


Fig-5 Anther lobe colour: A- Creamish anther; B- White anther; C- Bluish white anther

9. Fruits

The fruits were berries enclosed in persistent calyx and sub-globose in shape [Fig-6]. The characteristics of the fruit were as followed:

9.1 **Calyx length**: The fruits were enclosed in enlarged, 10- ribbed, reticulately veined calyx, which was upto 4 cm long. The length of the persistent calyx was measured from the tip to the base where it was joined to the stalk.

9.2 **Calyx diameter**: The inflated calyx was upto 6 cm in diameter when fully mature.

9.3 **Colour of unripe fruit**: The unripe fruit was green in colour.

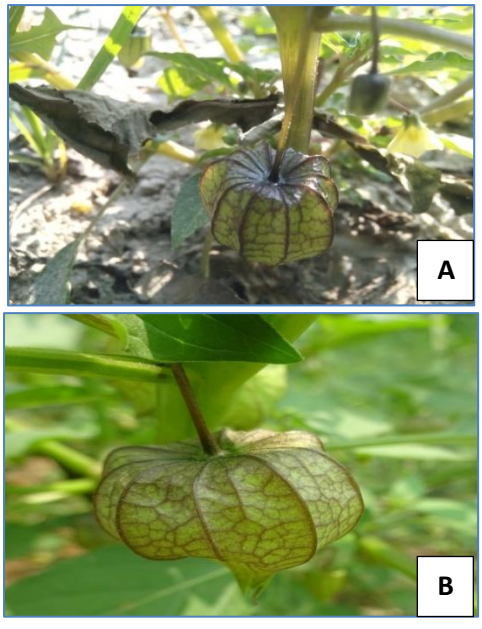
9.4 **Colour of ripe fruit**: The ripe fruit was generally greenish yellow but was yellow in some.

9.5 **Diameter of fruit**: Fully mature fruits were 3.2 cm to 3.6 cm in diameter.

9.6 **Number of seeds**: The average number of seeds per fruit was 105.

9.7 **Colour of seeds**: The unripe seeds were white while ripe were brown in colour. A fully mature fruit contained some ripe while other unripe seeds.

9.8 **Shape and size of seeds**: The seeds were flattened and almost round with a size of 1 mm X 1 mm.



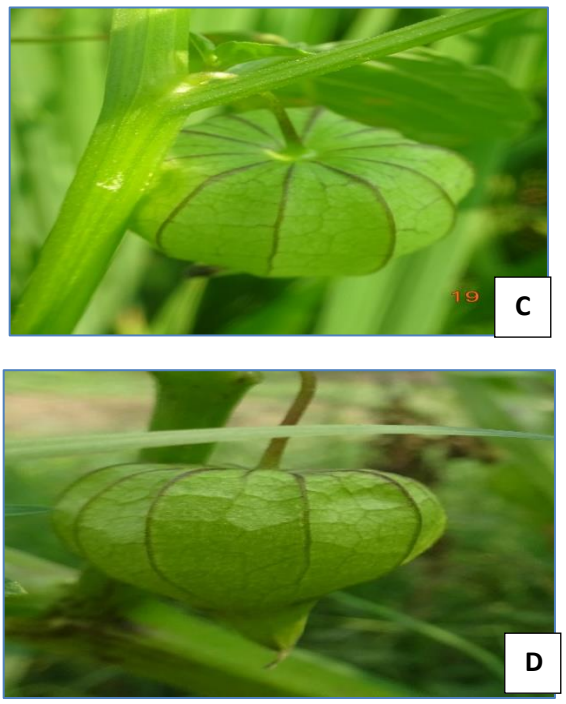


Fig-6 Types of fruiting calyces: A- Fruit with persistent calyx having purple base, purple primary veins and purple secondary veins; B- Fruit with persistent calyx having green base, purple primary veins and purple secondary veins; C- Fruit with persistent calyx having green base, purple primary veins and green secondary veins; D- Fruit with persistent calyx having green base, purple primary veins and purple secondary veins

The [Table-1] lists the different characters and their method of observation. The ranges of the measurable characters have been listed in the table. Based on these features different genotypes of the plants can easily be identified and distinguished from one another

Discussion

The *Physalis minima* is a herb which is mostly found growing as a weed along roadside, embankments of fields, wastelands, around the houses etc [9]. The plants are 50-150 cm tall. Based on height, two types of plants were identified- tall with height 80-150 cm and dwarf with a height of 50-80 cm. Parmar and Kaushal [10] described only one type of plants with an average height of 150 cm. Similar description was given by Pullaiah [11] who described only one type of plants with height around 30 cm, while Prajapati and co-workers [10] described it as a herbaceous annual of 15-30 cm height. Kirtikar and Basu [13] mentioned its heights as 15-30 cm whereas Raghavan [14] referred its height as 50 cm. Chothani and Vaghasiya [2] described it as an annual herb having 50-150 cm height as observed. The difference in plant height may be due to environmental effects. The tall plants were mostly found in regions where soil was porous and well irrigated while dwarf plants were found growing in wastelands and along roadside. The dwarf or tall plants may be glabrescent with smooth stem or pubescent with stems having minute hairs. The most common type in Bihar is the glabrescent type. Verma [8] in his book Flora of Bhagalpur mentioned the presence of both types in Bihar. The pubescent plants were referred as *P.minima* while glabrescent were referred as *P.minima* L. var. *indica*. The same description of the plant was given earlier by Hooker [15] and later by Kirtikar and Basu [13]. Raju and co-workers [7] described pubescent plants as *P. minima* while glabrescent plants were considered as *P.angulata*. The stem was either green or purple tinged. Mostly the pubescent plants were purple tinged while glabrescent were green. The plant shows dichotomous branching with dwarf plants having more profuse branching (30-35 branches) as compared to tall plants (10-15). The colours of the stem and branching pattern have not been specified earlier.

The plant had leaves which were ovate to chordate with entire, shallowly toothed or toothed margin. The leaves were either dark or light green having same colour

of dorsal and ventral surface. Some leaves had dark green dorsal surface and light green ventral surface. They were 4-11 cm long and 2-6 cm wide. Parmar and Kaushal [10] and Chothani and Vaghasiya [2] gave similar description of leaves which were 9.7cm long and 8.1cm broad with undulate margin. Verma [8], Kirtikar and Basu [13], Prajapati and co-workers [12] described leaves which were ovate with shallowly toothed or lobed margin while Raghavan [14] described leaves to have entire margin.

Table-1 *List of characters, their method of observation and range of measurable characters*

S.No.	Character	Method	Unit Or Rank	Range
1.	HABIT	Observation	Herb	-
2.	HEIGHT	Measurement	cm (integer)	50-150
3.	STEM			
3.1	Appearance	Observation	Glabrescent; Pubescent	-
3.2	Green	Observation	Yes; No (other colour specify)	-
3.3	Hairy	Observation	Yes; No	-
3.4	Erect	Observation	Yes; No	-
3.5	Dichotomous branching	Observation	Yes; No	-
3.6	Number of branches	Measurement	Integer (rounded to nearest decimal place)	10-35
4.	LEAVES (mature)			
4.1	Shape of margin	Observation	Entire; Shallowly toothed; toothed; others (specify)	-
4.2	Shape of apex	Observation	Acute	-
4.3	Reticulate venation	Observation	Yes; No	-
4.4	Colour	Observation	Light green; Dark green	-
4.5	Length	Measurement	cm (integer)	4-11
4.6	Breadth	Measurement	cm (integer)	2-6
5.	CALYX (fully open flower)			
5.1	Colour	Observation	Green	-
5.2	Purple colour at base	Observation	Yes; No	-
5.3	Reticulate venation	Observation	Yes; No	-
5.4	No of veins	Measurement	Integer (rounded to nearest decimal place)	10 primary veins
5.5	Colour of primary veins	Observation	Purple; Green	-
5.6	Colour of secondary veins	Observation	Purple; Green	-
5.7	Campanulate	Observation	Yes; No	-
5.8	Gamosepalous, five fused	Observation	Yes; No	-
5.9	Length	Measurement	mm (Integer)	3-6
6.	INFLORESCENCE	Observation	Single flower	-
7.	COROLLA(fully open flower)			
7.1	Colour	Observation	Light yellow; Yellow; others (specify)	-
7.2	Spot at base	Observation	Clear; Dark yellow; Brown; others (specify)	-
7.3	Gamopetalous, five fused	Observation	Yes; No	-
7.4	Campanulate	Observation	Yes; No	-
7.5	Size	Measurement	Cm (integer) X cm (integer)	1.2X1.2
8.	STAMEN			
8.1	No. of anthers	Measurement	Integer	5
8.2	Colour of anthers	Observation	Creamish; Whitish; Bluish white	-
8.3	Epipetalous	Observation	Yes; No	-
9.	FRUITS (mature, unripe)			
9.1	Persistent calyx	Observation	Yes; No	-
9.2	Calyx length	Measurement	cm (Integer)	Upto 4
9.3	Calyx diameter	Measurement	cm (Integer)	Upto 6
9.4	Colour of base	Observation	Purple; Green	-
9.5	Colour of primary veins	Observation	Purple; Green	-
9.6	Colour of secondary veins	Observation	Purple; Green	-
9.7	Sub-globose fruit	Observation	Yes; No	-
9.8	Colour of unripe fruit	Observation	Green	-
9.9	Colour of ripe fruit	Observation	Greenish yellow	-
9.10	Diameter of fruit	Measurement	cm (Integer)	3.2-3.6
9.11	Number of seeds	Measurement	Integer (rounded to nearest decimal place)	100-110
9.12	Colour of unripe seeds	Observation	White	-
9.13	Colour of ripe seeds	Observation	Brown	-
9.14	Shape of seeds	Observation	Flat, round	-
9.15	Size of seeds	Measurement	mm (Integer) X mm (Integer)	1X1

The *P.minima* plant bore solitary flowers which were 1.2-1.4 cm in diameter. The flowers were campanulate, yellow, light yellow or greenish yellow in colour. The corolla either clear or had dark yellow, brown or black spots within the corolla cup. Verma [8] highlighted that the *P.minima* had corolla with purple spots while Parmar and Kaushal [10] mentioned the presence of black spots in the middle of yellow background. These descriptions were supported by Kirtikar and Basu [13] and Chothani and Vaghasiya [2]. The flowers having clear corolla were described by Pullaiah [11], Raju and co-workers [7], Prajapati and co-workers [12] and Raghavan [14]. However, Verma [8] described that the plants with glabrescent type bear flowers with clear corolla while pubescent type plant bear flowers with spotted corolla. But no such correlation was found in this study. These differences in leaves and fruits can again be attributed to the differences in environmental conditions.

Mako plant bore flowers with epipetalous stamen which were 1-2 mm long with 6-7 mm long black or purple filament. The anther lobes were white, bluish white or creamish. It is very intriguing that the patterns of corolla and anther lobe colour seem to be related. The flowers with clear corolla bore only bluish white or rarely white anthers whereas plants having spotted corolla bear creamish anthers. This pattern has not been investigated in details before by many workers. Raju and co-workers [7] and Chothani and Vaghasiya [2] described anthers with black filament

and greenish yellow anther lobes but no correlation has been mentioned between corolla colour and anther lobe colour. The fruits of mako were berry enclosed in bladder like papery calyx. The persistent calyx was about 4 cm in length and 6 cm in diameter. It showed reticulate venation with ten primary veins and many secondary veins. The primary veins were mostly purple but were green in some. The secondary veins were either purple or green. The calyx base was purple in some fruits while green in others. The pubescent plants mostly bore fruits having calyx with purple base. Similar description of the fruiting calyx was given by Verma [8], Pullaiah [11], Prajapati and co-workers [12], Raghavan [14] and Chothani and Vaghasiya [2], but none of them mentioned the colour pattern of the calyx. The differences are mainly region specific. The plants in one region are more similar to one another as compared to other regions. These variations may be attributed to environmental conditions like soil type, temperature, humidity and others. Within a region the variations may be genetic.

Conclusion

Ban tipariya' is a very important fruit and medicinal plant having a large amount of unexplored biodiversity. The characterization of this plant is necessary for utilization of plant genetic resources. But a lack of standard documented description of this plant hinders the rapid characterization process. This work highlighted the various forms of the plant present in the Indian subcontinent particularly Bihar. The plant can be categorised into different forms on the basis of stem type, leaves margin and colour, calyx characteristics, fruit characteristics and others. These characters can be used to identify diffent genotypes of the plant in Bihar.

Application of Research

Physalis minima L. is a very important medicinal and fruit plant, which is on the verge of extinction. This article describes the work carried out to accomplish the characterization of this plant which will help in its conservation. The results of this work will help in development of descriptor of this important plant.

Abbreviations- L.-Linnaeus; P.-*Physalis*; mm-millimetre; cm-centimetre; Fig.-Figure

Research Category: Agricultural biodiversity

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Conflict of Interest: None declared

Ethical Approval: We hereby declare that this article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Usaizan N., Abdullah N. A. P. and Saleh G. (2014) *Journal of Applied Science and Agriculture*, 9, 18-25.
[2] Chothani D. L. and Vaghasiya H. U. (2012) *Indian Journal of Natural Product and Resources*, 3, 477-482.
[3] Sullivan J. R. (1984) *American Journal of Botany*, 71, 815–820.
[4] Ukwubile C. A. and Oise I. E. (2016) *International Biology and* Biomedical Journal, 2(4), 167-170.
[5] Whitson M. and Manos P.S. (2005) *Systematic Botany*, 30(1), 216–230.
[6] Deb D.B. (1979) Solanaceae in India. *In*: Hawkes, J.G., Lester, R.N., Skelding, A.D. (Eds.) *The Biology and Taxonomy of the Solanaceae*. London Academic Press, 87–112.
[7] Raju V.S., Reddy C.S. and Rajarao K.G. (2007) *Acta Phytotaxonomica Sinica*, 45, 239-245.
[8] Verma S.K. (1981) Solanaceae. *In*: *Flora of Bhagalpur Dicotyledons*. Today's & Tomorrow's Printers and Publishers, New Delhi, 266-267.
[9] Nandi S., Hembaram S., Adhikari A., Tiwar B.K. and Dutta S. (2017) *Bioinformation*, 13(10), 333-338.
[10] Parmar C. and Kaushal M.K. (1982) *Physalis minima*. *In*: Wild Fruits. Kalyani Publishers, New Delhi, India, 62-65.
[11] Pullaiah T. (2006) *Encyclopedia of World Medicinal Plants*. Regency Publications, New Delhi, 1519-1520.
[12] Prajapati N., Purohit S. S., Sharma A. K. and Kumar T. (2010) *A Handbook of* Medicinal *Plants*: A Complete Source Book. Agrobios, India, 394.
[13] Kirtikar K.R. and Basu B.D. (2008) *Indian Medicinal Plants*, 1766-1767.
[14] Raghavan V. (2011) *Comprehensive Medicinal Plants. Studium Press LLC*, 141.
[15] Hooker J.D. (1885) *Flora of British India. L-reeve & Co. Ltd*, 238.