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Original Article

Physalis ixocarpa: new species of genus *physalis* to the flora of Pakistan from mountainous region of district Shangla, Khyber Pakhtunkhwa Pakistan

Physalis ixocarpa: novas espécies do gênero *physalis* para a flora paquistanesa na região montanhosa do distrito de Shangla, Khyber Pakhtunkhwa, Paquistão

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Abstract

In the western mountainous region of Khyber Pakhtunkhwa Pakistan at the Shangla district, we found *Physalis ixocarpa* for the first time, not yet reported from Pakistan. *Physalis ixocarpa* was unidentified and has no ethnobotanical record in the flora of Pakistan. It is a member of family Solanaceae and having a close relation with *Solanum tuberosum* and *Lycopersicon esculentum*. The stem is prostrate with a dichotomous pattern of branches having leaves flower and fruits. Leaves are smooth, ovate and the margins of leaf blade dentation are poorly developed. The average length and width of the leaves are 6.50 and 3.61 cm respectively. *P. ixocarpa* grows to the length of 4-5 feet and an annual herb. The flowers of the plants are yellow in color and having purple color spots on the petals which are star-shaped. The round berry fruits are surrounded by persistent calyx and purple in color. The fruits are the 3-6cm in diameter. The plants are found in the different localities of district Shangla especially in Bar and Koz Kana. The life cycle of reporting plant is started in May and completed in November.

Keywords: *Physalis*, ethnobotanical study, flora, accessions.

Resumo

Na região montanhosa ocidental de Khyber Pakhtunkhwa, Paquistão, no distrito de Shangla, encontramos *Physalis ixocarpa* pela primeira vez, ainda não relatada nesse país. A *P. ixocarpa* não foi identificada e não possui registro etnobotânico na flora do Paquistão. É membro da família Solanaceae e tem estreita relação com *Solanum tuberosum* e *Lycopersicon esculentum*. O caule é rastejante com um padrão dicotômico de ramos com folhas, flores e frutos. As folhas são lisas e ovais e as margens da dentição da lâmina foliar são pouco desenvolvidas. O comprimento e a largura médios das folhas são de 6,50 e 3,61 cm, respectivamente. A *P. ixocarpa* cresce aproximadamente 120-150 cm de comprimento e é uma planta anual. As flores das plantas são de cor amarela com manchas roxas nas pétalas em forma de estrela. Os frutos redondos da baga são rodeados por cálice persistente e de cor roxa. Os frutos têm 3-6 cm de diâmetro. As plantas são encontradas em diferentes localidades do distrito de Shangla, especialmente em Bar e Koz Kana. O ciclo de vida da planta reportado é iniciado em maio e concluído em novembro.

Palavras-chave: *Physalis*, estudo etnobotânico, flora, acessos.

1. Introduction

Physalis ixocarpa is an important species of the genus *Physalis*. This genus was described by Carl Linnaeus in 1753 (Bardi and Marques, 2007). The genus *Physalis* belongs to the family Solanaceae. It contains more than 90 species distributed around the globe (Wei et al., 2012; Samules, 2015). Among this genus, only three species i.e. *Physalis minima, Physalis perviana, and Physalis alkekengi* have been reported for the flora of Pakistan (Stewart, 1972). The inflated calyx surrounding the berry and the presence of the pendant flowers are the identification features of this genus (Sullivan, 1984). Among the reported species of the genus, only four species are grown for their fruit in the different regions of the world (Singh et al., 2014; Zhang et al., 2016). One of the most important species of the genus *Physalis* is *P. ixocarpa,* shows similarity to the potato and tomato. This species has originated from the

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South American regions and widely grown in the regions of Mexico and Guatemala (Cantwell et al., 1992). These regions are also popular for the distribution of the wild *P. ixocarpa* (Peña Lomelí et al., 2002).

P. ixocarpa is reported from the different parts of the world. About seventeen accessions have been collected, identified and their seeds are stored in National Plant Germplasm System (USDA) the USA. However, up to till date it has not been reported from Pakistan according to the published Flora of Pakistan. The current study reveals the reporting of unidentified species (*P. ixocarpa*) of genus *Physalis* from Pakistan and this will become 4th species of genus *Physalis* in the ethnobotanical record of the flora of Pakistan.

2. Materials and Methods

Research group visited the different regions of District Shangla for the ethnobotanical study of medicinal plants in Sep 2020. During this trip, we found the plant species of genus *Physalis* which has not been reported by the flora of Pakistan. The samples of the species were collected from the regions of district Shangla including Koz kana, Bar Kana and Baylay Baba. The specimen was then identified according to the morphological features of the species.

3. Results

3.1. Collection and identification

The floral record of Pakistan presents the three different species of genus *Physalis* i.e. *P. minima, P. perviana,* and *P. alkekengii*. The species of this genus named *P. ixocarpa* has not been yet reported for the flora of Pakistan, was collected from district Shangla, and has been identified by Prof. Dr. Farukh Hussain, prominent plant taxonomist, Ex-Chairman, Department of the Botany University of Peshawar, Pakistan. Specimens were deposited in the herbarium of Islamia College Peshawar, Pakistan and recorded with voucher number (WD1). The comparative distinctive features of the available and non-reported species of genus *Physalis* in Pakistan are shown in Table 1.

3.2. Plant description

P. ixocarpa is locally called Tamatargay or China Tamatar. Morphologically it looks like a tomato and commonly found in tropical and subtropical condition (Figure 1). It is an annual herb and grows up to 4-5 feet. Plant body consists of stem, dichotomous branches, leaves, flowers, and fruits. Leaf is 6.53 cm long, 3.63 cm broad and smooth, ovate with poor leaf dentation. Flowers are yellow in color with purple spots in the form of star-like structure is present in their petals (Figure 2). Petals are yellow

Table 1. Comparative morphological features of the available species of *Physalis* in the flora of Pakistan with new accession of *Physalis ixocarpa*.

	Physalis peruviana	***Physalis alkekengi***	***Physalis ixocarpa***	***Physalis minima***
Plant height	30-60 cm	60 cm	48-60cm	15-45cm
Leaves	Ovate to ovate-cordate, sinuate to repand or toothed, pubescent, Leaf area is 4.5-14 x 3.5-10.5 cm.	Sinuate to sub entire, cuneate, and ovate to ovate-cordate. Leaf area is 7-11 x 4-8.2 cm.	Ovate smooth, pointed at apex, wedge-shaped at base; Leaf area is 6.53cm x 3.63cm.	Sinuate, ovate, repand or sinuate-dentate acute or acuminate, base cordate to oblique. Leaf area is 3-8 5(-11) x 1.5-4(-7) cm.
Calyx	Calyx length = ±7-9 mm, campanulate, inflated in fruit; triangular-acuminate lobes.	Calyx length= ± 6mm. Calyx color is orange-red; globose-conoid; triangular, acute or acuminate lobes.	Calyx length = 4-5 cm. Calyx color is green and changes to yellowish on maturity, conoid, globose and tenacious.	Calyx length= 2.5 mm Calyx is green in color, inflated, campanulate, globular-avoid and membranous.
Flower	Corolla is yellow in color with purple blotched, thin pubescent without shortly ciliated lobes. Anthers are 2-3 mm long and narrow oblong.	The flower is yellow-white in color, and 15-20 mm broad. Corolla is campanulate and 11-15mm long. Anthers are tight close against corolla tube.	Petals have purple central spots in the form of star-shaped structure. Corolla is campanulate and 8-10mm long. Anthers are 2-4mm long and blue or yellowish in color.	The flower is solitary axillary and creamy to yellowish in color. Corolla is yellow, lobes acute with 5mm in length. Anthers are ± 2 mm long.
Fruit	13 mm broad orange and globose	15 mm wide orange and globose.	Light orange or lemon color and fleshy globose berry with 3-6cm in diameter.	10 mm broad and orange in color.
Seed	Minutely reticulate, subreniform, brown in color and 2.4 mm long.	Minutely reticulate, compressed subreniform, brownish yellow in color and 2.2mm long.	Yellowish brownish in color with 2.5 mm long, often with pitted testa.	Compressed, minutely reticulate, subreniform, brownish yellow in color with 2.2 mm long.

in color, 8-10 mm long and campanulate. Anthers are blue or yellowish in color, 2-4 mm long and gynoecium bicarpellary, syncarpous and oblique. The fruits are fleshy globose berry, light orange or lemon in color with 3-6 cm in diameter (Figure 3). Internally fruit consists of three layers epicarp, mesocarp, and endocarp. Epicarp is thin, while mesocarp and endocarp are fleshy. Fruits are different in size, number and weight. The largest fruits develop from the first flowers of the main branches. The fruit is enclosed in husk known as Calyx. Calyx is 4-5 cm long and its color change into yellowish brown on maturity. Below the calyx sticky material is present on the outer surface of fruit with potent anti-inflammatory activity, which we have been reported in the previous study (Zhang et al., 2016). Seeds are 2.5mm long with pitted testa, which is numerous, yellowish brown and endospermic.

Figure 1. Plant of *Physalis ixocarpa*.

Figure 2. Flower of *Physalis ixocarpa*.

Figure 3. Fruit of *Physalis ixocarpa*.

Low temperature upsets the growth of the plant and makes it slow at temperatures of 16-18 °C or less. The life cycle of the reported plant starts from May and finished in November as the snowfall starts in Shangla district of Khyber Pakhtunkhwa Plant starts flowering from September and ends in November. Flowers are pollinated by bees.

3.3. Distribution of P. ixocarpa

Sandy and well-drained soil favor plant growth. According to information of National Plant Germplasm System USDA (USA), seventeen accessions of *P. ixocarpa* have been reported from different parts of the world. These include PI 291560 (India), PI 270459 (Mexico), PI 512011 (Mexico), PI 662847 (Mexico), PI 512010 (Mexico), PI 512009 (Mexico), PI 512006 (Mexico), PI 512005 (Mexico), PI 512007 (Mexico) PI 290968 (Argentina), PI 360740 (Ecuador), PI 662844 (Mexico), PI 662843 (Mexico), PI 309812 (Mexico), PI 512008 (Mexico), PI 662846 (California, United States) and PI 662845 (California, United States). Besides these accessions, here we are reporting *P. ixocarpa* from Pakistan.

3.4. The geographical locality of P. ixocarpa

In the western mountainous region of district Shangala KPK Pakistan, the plant specimens are found in different localities of Bayleybaba area, especially in Bar and Koz Kana. Bar Kana and Koz kana is situated between north latitude 34°-5504"-95', 34°-5742"-57' and east longitude 72°-9522"-35', 72°-4449"-74' respectively. Similarly, Bayleybaba area is present between east longitude 72°-4054"-63' and north latitude 34°-5334"-44' according to GPS reading. The geographical map of the plant reported area is shown in Figure 4.

3.5. Morphometric differentiation of the non-reported P. ixocarpa with available species of Physalis in Pakistan

Morphological features of the *P. ixocarpa* shown in Table 1 were noted during the present study which makes it different from the other existing species found in Pakistan.

3.6. Medicinal and economic importance

P. ixocarpa is cultivated as vegetable crop in USA and Mexico. It produces fruit, commonly called tomatillo. Traditionally, tomatillo is an important component of many sauces and Mexican dishes (Zhang et al., 2016). It is also used in folk medicine to relieve cough and fever (Maldonado et al., 2011). The leaves and calyx are also used in traditional medicine and rich of polyphenol (Khan et al., 2016a). Anolides and withanolides are the important bioactive compounds have been reported in different parts of this plant (Yang et al., 2021). Furthermore, cytotoxic activity, antimicrobial potential and apoptotic activities

Figure 4. Map of District Shangla indicating the locality of *Physalis ixocarpa* (Pak image.com).

have also documented in previous studies (Choi et al., 2006; Khan et al., 2016b).

4. Conclusion

The comparative morphological study of the subject plant with known species of genus *Physalis* available in Pakistan and observation of plant specimen by prominent taxonomist, clearly stated that unidentified plant is *P. ixocarpa*, and recommended for the addition to the flora of Pakistan.

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