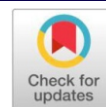


## Review Article

## Open Access

# Fruit morphological variability in *Cyclanthera pedata* (L.) Schrad: a neglected and underutilized vegetable crop of wet temperate zone of Himachal Pradesh, India



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## ABSTRACT

*Cyclanthera pedata* (L.) Schrad also known as Pahadi karela reported to be naturalized in hilly states of India. This species of the Cucurbitaceae family has medicinal properties like anticholesterolemic, anti-inflammatory and hypoglycemic properties. Despite these characteristics, it is an underexploited vegetable grown in the wet temperate zones of Himachal Pradesh. In the study, we aimed to investigate the morphological variability of *C. pedata* fruits and their locations variability grown in the Seeraj Valley of the state. The study included seven locations and a total of 31 genotypes, on which eight fruit morphological traits were analysed. The highest fruit length (11.80 cm), fruit width (3.84 cm), average fruit weight (360 gm) and fruit yield per plant (4.30 kg) was recorded in L2 location. Among seed traits, L7 (16.18mm), L4 (8.54 mm, 3.77 mm) and L2 (13.60 gm) observed the highest values for seed length, seed width, seed thickness and 100 seeds weight, respectively. The highest values for fruits size and yield traits of *C. pedata* were found at the high altitudinal gradient. In most of the hilly states, only small natural populations of the plants and self-supply production with little agronomic management can be seen. This neglected and underutilized plant is likely to increase the source of food, nutrition and economic growth of rural areas Collection of cultivars/landraces by surveying, and their maintenance could aid to the genetic improvement, breeding for sustainable and commercial production and popularization of the underutilized yet very important cucurbitaceous vegetable crop, *C. pedata*.

**Keywords:** *Cyclanthera pedata* (L.), Pahadi karela, ram karela, underexploited cucurbit, variability, Himachal Pradesh

## Introduction

Cucurbits are an important group of vegetables belonging to the family Cucurbitaceae. This family ranks first in the number and percentage of species used as human food. Cucurbits comprise 96 genera with approximately 1000 species. Out of the 1000 species of Cucurbitaceae, 10 are of worldwide economic importance, cultivated globally, and are here considered major cucurbit crops and around 23 are of more local commercial importance, are often cultivated in their native range, and might be called 'minor cucurbits' [1]. *Cyclanthera pedata* (L.) Schrad belongs to Cucurbitaceae is one of the minor cucurbit vegetable crops, commonly known as Pahadi Karela/ Ram Karela/ Meetha Karela in different states of India [6,9]. It is originated from South America, specifically from Andean region or Sierra where it was cultivated by Incas who used its fruits as food [3]. Currently *C. pedata* is cultivated in various parts of the world where it was introduced in Africa, China, India, Bhutan, Nepal, and Europe as a food [12].

Genus *Cyclanthera* is having 30 species that are native to warm temperate and tropical America, out of which *C. pedata* can withstand extreme temperatures (cold and hot) than any other species and usually free from foliar diseases and pests.

It can grow upto an elevation more than 2500 meters [13]. It is an annual climbing plant that can attain height of 5 meters or above provided with tendrils, palmate leaves, and small male and female flowers (monoecious species) at the leaf axil. The adult stem characterized with five prominent ridges. Leaves light to dark green, lobbed with five pinnatifid segments, oblong shaped, jagged edges and an acuminate apex. Male flowers are borne on long stalks in the small racemes in a group of 15-20 flowers, whereas, female flowers are borne on small stalks as solitary axillary or in pairs and found in smaller numbers compare to male flowers. The fruit is a green-pale/green ovoid pepo is usually 10-15cm long and 5-10cm in width having soft spines with curved ends. The mesocarp is thin and succulent while the endocarp is white and fluffy when mature, the inside of the ripe fruit is hollow, and contains dark-brown seeds roughly quadrangular attached to a placenta (Figure 1). The roots are shallow and extensive. The taxonomical hierarchy is presented in Table 1.

Fruits of this underutilized and neglected vegetable are edible both raw and cooked the mature fruits are cooked and can be filled with any stuffing (meat, fish or potato), while young and immature fruits are consumed raw as salads. The sprouts and the young leaves are edible as well [7]. *C. pedata* gained popularity in many developed countries due to its medicinal properties like anticholesterolemic, anti-inflammatory and hypoglycemic properties [10]. Viewing the medicinal importance of *C. pedata* in treating hypercholesterolemia and other high lipid related diseases, Diaz Rebolledo et al. [2]

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filed a patent (Patent No.: US 10,967,027 B2, Date of Patent: April 6, 2021) with the objective of provide a method of extraction of active materials from *C. pedata* that have had therapeutic activity against hypercholesterolemia which decreasing cholesterol levels on treating with the help of easily digestible solid-form extract (capsules form) of *C. pedata*. Mineral content was reported for this vegetable by Oliveira et al. [8] as follows: 0.91 for sodium, 152 for potassium, 19.4 for phosphorus, 11.9 for calcium, 8.4 for magnesium, 0.074 for manganese, 0.21 for iron, 0.013 for copper, 0.13 for zinc and 0.015 for vanadium (mg/ 100g). The plant chemical reported in *C. pedata* fruits include phenols, peptin, galacturonic acid, picrin, lipoproteins, flavonoids, alkaloids and vitexin. It thus represents an example of a plant used for medicinal purposes and can appropriately be considered within the above - described context of food plant with health-giving effects. For this reason, *C. pedata* has a commercial interest in the functional food markets of different countries.

In India, it is mainly found in natural habitats of hilly states like Himachal Pradesh, Uttarakhand, West Bengal, Sikkim and other North East. Himachal Pradesh, it is known as Pahadi Karela/ Meetha Karela where it is found in various parts of the state, especially high and mid hill zone of the state growing in small farms/ home garden with little agronomic management. *C. pedata* is considered less economically important among other main cucurbit vegetable crops and thus has often been neglected in scientific research. To the best of our knowledge, there is meager/ no morphological study of *C. pedata* populations in the state. In order to assess the fruit and seed morphological variability, the present study was done in the form of survey to get insight into the morphological traits of *C. pedata*, to determine their inter- and intra-population variability and to establish the relationship between fruit characteristics and geographical and environmental conditions.

The survey for morphological traits variability analysis was done in seven locations of Seeraj Valley of district Mandi of Himachal Pradesh, India (Table 2). Data were collected from 31 plants of *C. pedata* from different surveyed locations, then proceeded for phenotypic evaluation of morphometric and yield contributing traits.

The survey was carried out at seven different locations of Seeraj valley. Total 31 plants grown by rural peoples of the areas are located from seven surveyed villages for further study and seed collections. The vigorous growth of vines was seen in semi-shady areas having rich and moist soils. Usually, single plant or two were planted together near apple trees or backyards. The planting time of this vegetable was recorded after interviewing the people in their local dialect. Most of the rural people propagated *C. pedata* by seeds in the month of May (second fortnight). The harvesting of fruits can be done from September onwards which continue up to November. No evidence of any foliar disease and insect pest was recorded during the survey. Some fruits are left to mature in the field for collecting seeds which are later used to grow the crops for the next season.

The plant traits related to different fruit phenotypic traits viz., seed, yield and yield contributing characters were recorded. In total, eight morphological traits were examined. viz., fruit length (cm), fruit width (cm), seed length (mm), seed width (mm), seed thickness (mm), average fruit weight (gm), average fruit yield (kg), 100 seed weight (gm). Data for variability analysis were obtained from 10 random, unripe, undamaged fruits with stalks, taken from the initially collected 30 fruits from each plant.

The fruit traits were recorded at a unripe, marketable stage and harvesting stage. The seed traits were assessed at the post-harvest stage.

In order to determine the range of variation for each population, descriptive statistics, including arithmetic mean, standard deviation, minimal values, maximal values, and coefficient of variation, were calculated for all of the studied morphological traits on individual population level. Furthermore, the differences in fruit traits between studied populations were carried out by the analysis of variance (ANOVA). Afterwards, the principal component (PC) analyses were conducted in order to reveal the interactions between the analysed variables, and to reduce all of the components to the lower number of factors. Fruit morphological data taken from different plants of *C. pedata* from different locations were characterized and listed in table 3 which was revealed to have yellow flowers with light to dark green foliage, fruit surface colour varied from dark green to light green, small, medium to large fruits having spine to spinless fruits surface, ovoid and curved fruit shaped was noticed. The fruit endocarp and seeds of most of the *C. pedata* populations were white and dark brown, respectively.

Variability in all the proximate traits of plant population under study was showed in figure 2. The highest fruit length (11.80 cm), fruit width (3.84 cm), average fruit weight (360 gm) and fruit yield per plant (4.30 kg) was recorded in L2 (Upper Mayadhar). Among seed traits genotypes viz., L7, Kiling (16.18mm), L4, Mughan (8.54 mm, 3.77 mm) and L2, Upper Mayadhar (13.60 gm) observed the highest values for seed length, seed width, seed thickness and 100 seeds weight, respectively. On the other hand, data based on locations (Table 4) showed that L1 (Lower Mayadhar) recorded the lowest values for fruit length, seed length and 100 seed weight. Minimum values for fruit width, seed width and seed thickness were observed in L6 (Thunag main). Low average fruit weight and average yield per plant were found in L4 (Mughan) and L5 (Thunag main), respectively. Results showed the greatest variability among traits in L2 (Upper Mayadhar). High morphological variability of *C. pedata* fruits was found, both on inter and intra-population level. It was further revealed that inter-population variability explains most of the total variability, indicating high morphological distinction between the genotypes of the

Principal component (PC) analysis based on eight morphological fruit and seed traits revealed that the first two principal components explained 69.00 % of the total variability (Table 5). Average fruit weight, fruit width and fruit length were in high positive correlation with the first principal component. Whereas, 100 seed weight and seed width was in positive correlation with the second PC.

As fruit size, fruit weight and yield per plant are most important factors in breeding, populations with the highest values for these above said traits (L2) and seed characters like seed width, length, thickness and test weight (L4 and L2) could be considered to have the fruit of the best quality. This information could find use in conservation-through-use approach, which is based on the premise that the conservation of the species could be achieved through its health and economic benefit for local/ rural communities.

Hilly regions are considered as treasure trove of various wild and unexploited edible plant species. *C. pedata* is not been intensively exploited in the country as well in the state. In most of the hilly states, only small natural populations of the plants and self-supply production with little agronomic management can be seen.

This neglected and underutilized plant is likely to increase the source of food, nutrition and economic growth of rural areas. Efficient utilization of this crop may add to the available plant-based drugs due to its anticholesterolemic, anti-inflammatory and hypoglycaemic properties for present and future generation. Genetic variability in crops is of paramount importance in selecting the best genotypes for rapid improvement of yield and its related characters, and for selecting the most potential parents for a successful hybridization programme. Our results confirmed high location variability in regards to fruit morphology and yield and yield related traits. In addition, we found out that altitude proved to significantly influence fruit morphological and yield traits, as it was positively correlated to fruit size and yield and average fruit yield of the plant. Big sized dark green with soft spined fruits with high average yield and seed test weight was noticed in location having high altitude as compared to other locations under study.

**Future scope of study:** There is a need to promote the use of this neglected yet important cucurbitaceous crop by carrying out research on identification, collection, and conservation of an elite genotypes from different locations of Himachal Pradesh, also very little scientific attention has been received on particular crop therefore, collaborative germplasm exploration and exchange program needs to be conducted to better understand the potential opportunities. The popularization and characterization of *C. pedata* would help to generate scientific documentation, it would help create awareness about health benefits and importance of sustaining food and nutritional security among the rural people and farming communities of hilly regions of Himachal Pradesh.

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### Statements and Declarations

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### Author contribution

KS: Conducted survey, recording data, preparation of manuscript and interpretation of data, DS: preparation and revision of manuscript, SKJ: analysing and interpretation of data, AS: revised manuscript.

### Conflict of interest

The authors declare no competing financial interests.

### Data availability statement

The data generated during the current study are available from the corresponding author on reasonable request

**Table 1: Botanical classification of *Cyclanthera pedata* (L.) Schrad**

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Cucurbitales
Family	Cucurbitaceae
Subfamily	Cucurbitoidae
Tribe	Sicyoeae
Genus	<i>Cyclanthera</i>
Species	<i>Pedata</i>
Ploidy	Diploid
Chromosome number	2n=32
Botanical name	<i>Cyclanthera pedata</i> (L.) Schrad
<b>Vernacular names in Indian province</b>	
<b>Province</b>	<b>Vernacular names</b>
Himachal Pradesh	Pahadi Karela, Metha Karela
Uttarakhand	Ram Karela, Korila
Sikkim	Chuche Karela
West Bengal	Chuche Karela

**Table 2: Name of locations, number of samples, acronyms, altitude and geographic coordinates of *Cyclanthera pedata* L. populations**

Name of Location	Number of samples	Acronyms	Altitude (m)	Latitude	Longitude
Lower Mayadhar (L1)	2	G1, G2	1977	31.54348	77.15729
Upper Mayadhar (L2)	3	G3, G4, G5	2019	31.55100	77.15536
Joodh (L3)	10	G6, G7, G8, G9, G10, G11, G12, G13, G14, G15	1966	31.54816	77.16397
Mughan (L4)	6	G16, G17, G18, G19, G20, G21	1970	31.55574	77.16193
Thuang Lower (L5)	3	G22, G23, G24	1859	31.55291	77.16575
Thuang Main (L6)	1	G25	1965	31.55532	77.16172
Kiling (L7)	6	G26, G27, G28, G29, G30, G31	1480	31.51079	76.98250

**Table 3 Evaluation of *Cyclanthera pedata* L. genotypes collected from different locations for morphological traits**

Genotypes	Fruit surface colour	Soft spines	Fruit length	Leaves colour	Seed colour
G1	Light green	Present	Small	Dark green	Dark brown
G2	Dark green	Present	Medium	Dark green	Dark brown
G3	Dark green	Present	Large	Dark green	Dark brown
G4	Light green	Present	Medium	Light Green	Dark brown
G5	Dark green	Present	Medium	Dark green	Dark brown
G6	Light green	Absent	Small	Light Green	Dark brown
G7	Dark green	Present	Small	Dark green	Dark brown
G8	Light green	Absent	Large	Dark green	Dark brown
G9	Dark green	Present	Medium	Dark green	Dark brown
G10	Dark green	Present	Medium	Dark green	Dark brown
G11	Light green	Present	Medium	Dark green	Dark brown
G12	Dark green	Absent	Small	Dark green	Dark brown
G13	Dark green	Present	Medium	Dark green	Dark brown
G14	Dark green	Present	Small	Dark green	Dark brown
G15	Dark green	Present	Large	Light Green	Dark brown
G16	Light green	Present	Small	Dark green	Dark brown
G17	Light green	Present	Small	Dark green	Dark brown
G18	Dark green	Present	Medium	Dark green	Dark brown
G19	Light green	Present	Medium	Dark green	Dark brown
G20	Light green	Present	Medium	Dark green	Dark brown
G21	Light green	Present	Medium	Dark green	Dark brown



G22	Dark green	Present	Medium	Light Green	Dark brown
G23	Dark green	Absent	Small	Dark green	Dark brown
G24	Light green	Present	Small	Light green	Dark brown
G25	Dark green	Present	Medium	Light green	Dark brown
G26	Dark green	Present	Medium	Dark green	Dark brown
G27	Dark green	Present	Medium	Dark green	Dark brown
G28	Dark green	Present	Small	Dark green	Dark brown
G29	Dark green	Present	Small	Dark green	Dark brown
G30	Dark green	Present	Small	Dark green	Dark brown
G31	Dark green	Present	Medium	Dark green	Dark brown

Table 4 Mean values of different horticultural and yield traits of *Cyclanthera pedata* (L.)

Level		Fruit length (cm)	Fruit width (cm)	Seed length (mm)	Seed width (mm)	Seed thickness (mm)	Average fruit weight/plant (gm)	Average yield/plant (kg)	100 seed weight (gm)
L1	Mean	6.85	2.15	9.26	6.62	2.52	145.00	1.95	7.25
	SEM	0.28	0.11	0.19	0.12	0.07	12.65	0.75	1.40
L2	Mean	9.42	2.91	11.44	6.98	3.01	233.33	4.71	11.08
	SEM	0.23	0.09	0.15	0.10	0.06	10.33	0.61	1.14
L3	Mean	7.49	2.11	11.01	7.13	2.99	131.17	1.87	9.29
	SEM	0.12	0.05	0.08	0.05	0.03	5.66	0.34	0.62
L4	Mean	7.22	2.15	12.92	7.30	3.26	84.44	1.05	10.49
	SEM	0.16	0.06	0.11	0.07	0.04	7.30	0.43	0.81
L5	Mean	7.01	2.14	10.34	6.51	2.85	110.56	0.83	8.07
	SEM	0.23	0.09	0.15	0.10	0.06	10.33	0.61	1.14
L6	Mean	8.20	2.10	15.26	6.28	1.95	135.00	1.00	8.50
	SEM	0.39	0.15	0.26	0.16	0.10	17.89	1.06	1.98
L7	Mean	7.42	2.53	13.55	7.23	2.62	160.56	1.70	10.21
	SEM	0.16	0.06	0.11	0.07	0.04	7.30	0.43	0.81
CD		0.71	0.28	0.48	0.30	0.20	32.65	2.02	3.71

\*SEM: Standard Error of Mean

Table 5 Pearson correlation coefficients between horticultural and yield traits of *Cyclanthera pedata* (L.) and scores of the first four principal components (PC)

Variables	Principle Components (PC)			
	PC1	PC2	PC3	PC4
Fruit length (cm)	0.89583	0.00124	-0.09012	-0.03005
Fruit width (cm)	0.92062	0.02292	-0.18127	-0.00179
Seed length (mm)	0.13504	0.67951	-0.59466	-0.32273
Seed width (mm)	-0.11429	0.72163	-0.00506	0.66038
Seed thickness (mm)	-0.10509	0.71430	0.38239	-0.41321
Average fruit weight (gm)	0.93849	-0.08230	-0.04440	0.15487
Average fruit yield/plant (kg)	0.74279	0.03979	0.53499	-0.06282
100 seed weight (gm)	0.09724	0.93840	0.12138	0.05673
Eigenvalue	3.1344	2.3822	0.8438	0.7431
% Total	39.179	29.778	10.547	9.288
Cumulative	39.179	68.957	79.504	88.792

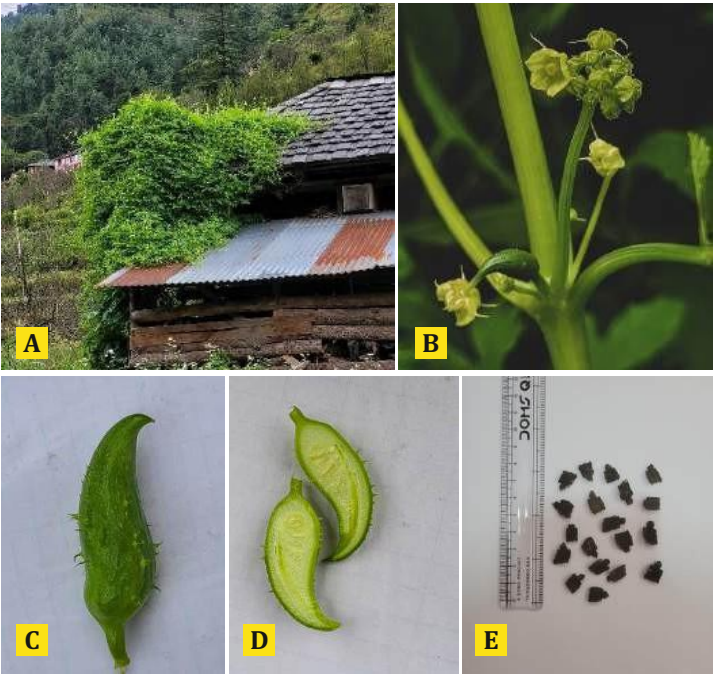
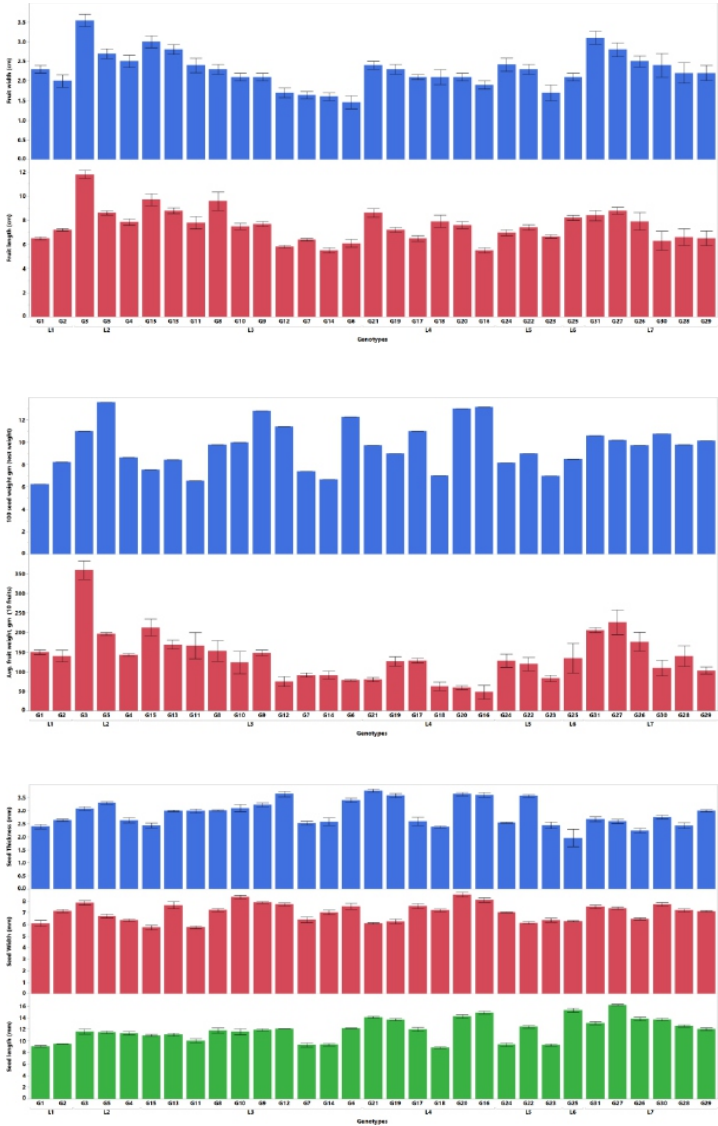


Fig. 1 *Cyclanthera pedata* (L.) Schrad plant growth at Seeraj valley (A), male & female flower (B), Fruit (C), TS of fruit (D), mature seeds (E)



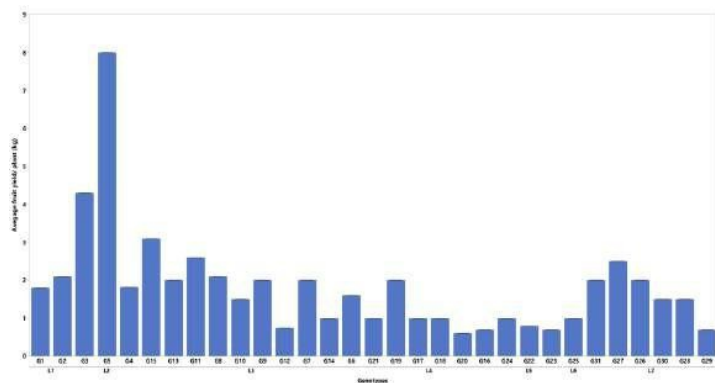


Figure 2 Arithmetic means for analysed horticultural and yield traits in *Cyclanthera pedata* (L.). Locations L1 (Lower Mayadhar), L2 (Upper Mayadhar), L3 (Joodh), L4 (Mughan), L5 (Thunag lower), L6 (Thunag main), L7 (Kiling)

## References

- Chomicki G, Schaefer H, Renner SS (2020) Origin and domestication of Cucurbitaceae crops: insights from phylogenies, genomics and archaeology. *New Phytol* 226(5):1240–1255 doi: 10.1111/nph.16015
- Díaz Rebolledo AM, Perez C, Rebolledo. Extracts of *Cyclanthera pedata* and formulations and uses thereof. US Patent US 10,967,027B2, 2021
- Fernández Honores AM, Rodríguez Rodríguez EF (2007) Etnobotánica del Perú pre- hispánico. Universidad Nacional Trujillo, Peru
- Monigatti M, Bussmann RW, Weckerle CS (2013) Medicinal plant use in two Andean communities located at different altitudes in the Bolívar Province, Peru. *J Ethnopharmacol* 145:450–464. <https://doi.org/10.1016/j.jep.2012.10.066>.
- Oliveira AD, Silva dos Santos V, Correia dos Santos D, Carvalho RDS, Souza AS, Ferreira SLC (2014) Determination of the mineral composition of Caigua (*Cyclanthera pedata*) and evaluation using multivariate analysis. *Food Chem.* 152: 619-623
- Rai S, Rai U, Sarkar RK, Golay S (2022) Chuche Karela (*Cyclanthera pedata* (L.) Schrad- An underexploited vegetable crop grown in the hills of West Bengal and Sikkim. *Vigyan Varta* 3(5): 13-16
- Rivas M, Vignale D, Ordonez RM, Zampini IC, Alberto MR, Sayago JE, Isla MI (2013) Nutritional, antioxidant and anti-inflammatory properties of *Cyclanthera pedata*, and Andinean fruit and products derived from them. *Food Nutr Sci* 4:55–61. <https://doi.org/10.4236/fns.2013.48A007>
- Siemonsma and Piluek, eds. (1994) Plant Resources of South- East Asia. No. 8.
- Vegetables. PROSEA, Bogor, Indonesia. 2. Pacific Island Ecosystems at Risk.
- Zuccolo M, Pedrali D, Leoni V, Borgonovo G, Bassoli A, Giorgi A, Giupponi L (2023) Characterization of an Italian landrace of *Cyclanthera pedata* (L.) Schrad. of herbal and horticultural interest. *Genet Resour Crop Evol* 70:1455-146 <https://doi.org/10.1007/s10722-022-01514-3>