



## A REVIEW ON PHARMACOGNOSTICAL AND PHARMACOLOGICAL ACTIVITIES OF PLANT *NICANDRA PHYSALODES*

Abhijit Gupta<sup>1\*</sup>, Prachi Singh<sup>2</sup>, Neelanchal Trivedi<sup>1</sup>, Keshari Kishore Jha<sup>1</sup>,  
Sachin Kumar<sup>1</sup>, Bhuvnesh Singh<sup>1</sup>

1\* Teerthanker Mahaveer Collage of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

2 Department of Pharmacy, IFTM University, Moradabad, Uttar Pradesh, India

### ARTICLE INFO

Published on: 15 Jun 2014

ISSN: 0975-8216

### Keywords:

*Nicandra physalodes*,  
nicandrenone, withanolide,  
withaperuvin E, nicandrin.

### ABSTRACT

*Nicandra physalodes* a member of the Nightshade belonging to family solanaceae and known as apple of Peru. This plant is also known by name shoo fly plant because it has potent insects repellent property due to the presence of nicandrenone as a main active chemical constituent. Various alkaloids like withanolide, withaperuvin E and nicandrin B are isolated from this plant which is responsible for various pharmacological activities. The literature survey of the plant possessed various pharmacological activities like antidiabetic, diuretic, antimicrobial etc. It also shows in-vitro cytotoxic activity. Traditionally it is used as Analgesic, anthelmintic, antibacterial, anti-inflammatory and febrifuge and its regular use also increases bodily vigour. It is also used in the treatment of contagious disorders, toothache, and intestinal pain from worms and in impotence. On the basis of their traditional use and scientific investigation, this plant is considered to be very important according to medicinal point of view. This review is an attempt to discuss the various pharmacological, medicinal properties and other important information regarding this plant. This review will help the researchers to know its proper usage as this plant is seemed to be highly valuable.

\*Corresponding Author:

Abhijit Gupta

Assistant Professor, Teerthanker Mahaveer Collage of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

### INTRODUCTION

The herbal preparation symbolizes more beneficial than the synthetics that are regarded as unsafe for human health. A medicinal herb contains variety of natural

chemical constituents, therapeutic agents as well as active chemical constituent with different medicinal property [1].

Herbal remedies can work more efficiently than the synthetic one without eliciting any adverse effect like modern synthetic medicine. According to World Health Organization (WHO) it is estimated that in the developing countries about 80% of the population relies almost exclusively on herbal medicine [2]. Nature has blessed our country with an enormous wealth of medicinal plants. India has been also considered as the medicinal garden of the world [3]. The evaluation of herbal drugs based on the phytochemical, pharmacological and applied approaches with the help of various instrumental techniques [4].

*Nicandra physalodes* is a member of the Nightshade family and introduced into the United States from tropical America as an ornamental plant. Habitats include those areas, which are adjacent to flower gardens; it also grows in areas that are along with roadside ditches, fallow fields and cropland. It does not persist in wild. This species is having blue color attractive flowers and hence occasionally cultivated in flower gardens. The foliage of this plant is toxic to mammalian herbivores usually avoids its intake. In the southern states, the juices extract out from the foliage and roots were mixed with milk to attract flies and flies get died after fed from this concoction, that is why this plant is also known by name 'Shoofly Plant' [5]. It is native to Peru and hence also called as Apple of Peru of that area and produces a fruit that is similar to tomatillos. It is an annual weed belongs to the tomato family and it reproduce by seed only. This plant grows continuously in spring, summer, and if moisture is present it may fall in agricultural fields. Various Herbicides that are used to control other weeds in vegetable crops do not control this weed adequately. Control in field crops is variable [5].

This plant is a confirmed alternative host for cucumber mosaic virus. Apple of Peru is found to be a serious weed problem in various countries like Asia, Australia, East and Southern Africa and South America. It is one of the noxious weeds that grow in soybean fields of Brazil. Agricultural land in North

Central Ohio has become infested with apple of Peru recently, in the last 5–7 years. These infestations are mustered in Seneca and Sandusky countries [6].

#### FACTS ABOUT APPLE OF PERU

It is a prolific seed producer. Due to seed dormancy large, persistent seed banks quickly accumulate in the soil. Apple of Peru is found to be very competitive with vegetable crops and soya bean. Apple of Peru has low sensitivity towards the commonly used herbicides. Following is the list of sensitivity of this plant towards common herbicides:

Group	Response
PPO Inhibitors -	Sensitive
Chloroacetamides -	poor-moderate
ALS Inhibitors-	poor
Triazines-	poor
Bleaching-	sensitive

#### PLANT DESCRIPTION

*Nicandra physalodes* belongs to the family of solanaceae and it is known by common name ran popti [7]. Plant is 1 meter in height and its branches spreading vigorously with ovate, toothed and wavy leaves. The flowers are pale violet in colour with white throats and are bell shaped as shown in figure 1. At the end of their bloom they become lantern-like sometimes erect. The plant is thought to have insect repellent properties [5].

#### SCIENTIFIC NAME

- *Nicandra physalodes*

#### SYNONYMS

- *Atropa physalodes* L. (basionym)
- *Pentagonia physalodes* L. (Hiern)

#### COMMON NAMES

- English - apple-of-Peru
- English- broadleaf-nightshade
- English- shoofly plant
- French- nicandra
- German- Giftbeere
- Spanish- capulí cimarró
- Swedish- ballongblomma

#### DISTRIBUTION

It is arable land weed in 35 countries and is distributed worldwide. It is widespread in India, eastern Mediterranean, central America and central latitude of south America. It is

quite troublesome in Australia and southern and eastern Africa.

**CULTIVATION:**

It is found most often in cultivated place but it also grow on road side and waste land [8].

**MORPHOLOGICAL CHARACTERS:**

**ROOT:** The root system consists of a taproot.

**STEMS:** Stems are angular and hairless, grooved or furrowed lengthwise.

**LEAVES:** The alternate leaves are up to 6 to 25 cm long and 2.5 to 18 cm wide across, sparsely pubescent and ovate-cordate. Margins of leaf are shallowly lobed, bluntly dentate, and undulate. The petiole of leaf is 1 to 20 cm long and slender, tilting at an upward angle.

**FLOWER:** Flower develops from the axils of the upper leaves. It consists of a spreading light blue and lavender corolla with 5 shallow lobes. It are near about 1–1½" across and are diurnal and short-lived. It is pale blue, white, or blue with white centre its blooming season is summer and lasts up to 2-3 months.

**SEEDS:** Seeds are light brown in colour, glabrous and having finely pitted testa. Seeds are 1.25 to 1.5 mm in diameter. In a growing season seeds germinate earlier and then sporadically through cropping period.

**FRUITS:** Fruits are smooth berries, yellowish and glabrous with 1 to 1.5 cm in diameter spheroidal and develop within the enclosing sepals of the calyx and about ½" across and divided into 4 or 5 cells. Fruit is full of seeds and dry in texture .It is mainly grown in moist to mesic conditions and it needs loamy fertile soil [8].

**MICROSCOPY**

**MICROSCOPY OF FLOWER OF NICANDRA PHYSALODES**

**CALYX**

The sepals are, 20-22 mm long and 14-15 mm wide, Sagittate and overlapping only at their base. Their epidermis is covered by many trichomes: simple, pluricellular with a lengthened cuticle at its apex, and formed by 4-5 cells with glandular head

**COROLLA**

At the border it is blue colour with a whitethroat. It is 30-32 mm long and 20- 21 mm wide. Trichomes on external epidermis are similar to calyx.

**ANDROECIUM**

The androecium consists of five equal length stamens. The filaments are geniculate and at the base these are pubescent and eglandular simple hairs are, forming compact pads in huge amount. Simple trichomes are found throughout the surface of anthers. Anthers are 5-6 mm in length. The endothecium is composed of two or three strata of cells with fibrous thickenings. The stomium is consisting of two or three layers of small isodiametric cells having light colored contents. All pollen sacs are fertile with pollen grains, normal endothecium, and tapetum.

**GYNOCIUM**

The stigma is capitate, consist of five stigmatic areas. The pluricellular papillae present on receptive surface, are intertwined and help in the formation of stigmatic channels .The style is glabrous and there is a dearth of stomata. The ovary consists of five carpels and contains seven locules because at the base of the ovary there is a presence of false septa. The parenchymatic cells present in the ovary shows mixed-shaped crystals, crystalline sand druse crystals and amorphous glasses. The nectary at the base of the ovary is a ring with five smooth swellings. The secretory tissue contains layers of cells and stomata distributed only around the base of the nectar. Five dorsal and various lateral vascular bundles that ascend to the ovary's external wall irrigate the nectary.

**VASCULARIZATION**

*Nicandra physalodes* has a siphonostele that is not divided into separate vascular bundles. The vascular bundles of sepals, petals and stamens branch off without leaving lacunae. The calyx is irrigated by 15 vascular bundles (five are main bundles and the others lateral ramifications). The corolla also has the same as that of calyx that is 15 vascular bundles (five are main bundles and the others lateral ramifications). The divided stele gives rise to carpellary vascular system. The ovary is irrigated by 5 dorsal bundles and 10 ventral

bundles, irrigating the style and the 5 stigmatic areas respectively. [9]

#### **SEED STRUCTURE AND DORMANCY OF NICANDRA PHYSALODES:**

Different treatments were studied by the scientist in order to overcome dormancy and to state dormancy class and level, to characterize their seed morphology. The treatments applied were - mechanical seed coat scarification, gibberellins and chemical treatments. Detipped seed's germination and gibberellins were equally effective but chemical treatment was not effective to overcome dormancy. It confirms that the species shows physiological dormancy class. [10]

#### **CHEMICAL CONSTITUENTS:**

The alkaloids like withanolide, withaperuvin E and nicandrin B are isolated from the plant and characterized by means of chemical and spectroscopy [11]. A compound called 6-Hydroxykynurenic Acid (6-HKA) is also present in *Nicandra* and most of the species of solanaceae family. The presence of 6-HKA is taken as evidence in plants for the tryptophan-catabolic pathway already known in mammals and micro-organisms [12]. Nic-1-lactone, a minor steroidal constituent was also obtained from *nicandra* plant. 3-O- $\beta$ -D-glucopyranosyl-1 $\alpha$ , 2 $\beta$ , 3 $\alpha$ , 6 $\alpha$ -tetrahydroxynor-tropane are recently isolated compounds from *Nicandra physalodes* fruits (Solanaceae.) [13]. Nicandrenone is obtained from the leaves of plant *Nicandra physalodes*. This substance nicandrenone is insect's repellents with toxic properties. It is a conjugated ketone with molecular formula C<sub>33</sub>H<sub>44</sub>O<sub>7</sub>. This substance was showing insects repellent properties against housefly as well as hornworms. This repellent substance nicandrenone is obtained from the leaves by means of extraction [14]. *Nicandra physalodes* contains two new methyl steroids (2) and (3) the constitution of the former is demonstrated by crystallographic analysis of its acetate, using direct methods. [15] The roots of *nicandra physalodes* contain 0.1% hygrine [16].

#### **ECONOMIC IMPORTANCE**

##### **TRADITIONAL USES:**

Traditionally this plant was used to relieve pain like toothache, intestinal pain from worms. Its regular use also increases bodily vigour. This plant also used as anthelmintic,

antibacterial, anti-inflammatory and febrifuge [17]. The seeds are of cooling and very poisonous potency and used in Tibetan medicine. They are used in the treatment of contagious disorders and impotence. A decoction of the seeds of this plant is used for the treatment of fevers [www.naturalmedicinalherbs.net].

#### **PHARMACOLOGICAL PROPERTIES:**

##### **ANTI-DIABETIC ACTIVITY**

Abesundara KJ performed anti diabetic activity on plant *nicandra physalodes*. Butanolic extract of plant is used in type 2 diabetes by inhibiting  $\alpha$ -glucosidase. This inhibitor delays the absorption of ingested carbohydrates and thus reduces the postprandial glucose and insulin peaks [18]. Butanolic extract of plant is mainly used to determine the activity [19]. The  $\alpha$ -glucosidase enzyme is located in the brush border of the small intestine and is required for the breakdown of carbohydrates to absorbable monosaccharide. The AGIs ( $\alpha$ -Glucosidase Inhibitors) delay, but do not prevent, the absorption of ingested carbohydrates, reducing the postprandial glucose and insulin peaks [20].

##### **DIURETIC ACTIVITY**

Diuretic activity has been proved and cited by several investigators. Devi P performed diuretic activity on Wister rats of either sex using ethanolic and aqueous extract by increasing the excretion of Sodium, Potassium and Chloride. The presence of effective diuretic constituents in the Aqueous and Alcoholic extract of *Nicandra physalodes* results in Diuretics relieve pulmonary congestion and peripheral edema. There is a significant increase in sodium, potassium, and chloride ions in dose dependent manner with aqueous and alcoholic extract 100mg/kg. This lead to reduce the syndrome of volume overload decreases cardiac workload, oxygen demand and plasma volume, thus decreasing blood pressure [7].

##### **ANTIMICROBIAL ACTIVITY**

Mann AS carried out Antimicrobial studies on methanolic and aqueous extract of leaf, fruit, stem and root of *Nicandra physalodes*. Methanolic and aqueous extract of leaves and roots was active against fungi, *Candida albicans* and *Aspergillus flavus*. The microorganisms used in study were *Bacillus*

*subtilis* NCIM 2439, *Mycobacterium phelei*, *Proteus mirabilis* and *Staphylococcus edidermidis* NCIM 2493, *Candida albicans* and *Aspergillus flavus* NCIM535. Penicillin in mice, the 24 hour median lethal dose (LD50) was determined for gram-positive bacteria, streptomycin for gram-negative bacteria and clotrimazole for fungi were used as standard. The *Nicandra physalodes* extract, both methanolic and aqueous showed growth inhibition for gram positive and gram negative bacterial strains[21].

#### CYTOTOXICITY

The known withanolide nicandrenone (1) is responsible for the *in-vitro* cytotoxicity of *Nicandra physalodes* extracts[22].

#### TOXICITY PROFILE

The toxicity profile of *Nicandra physalodes* was studied in different animals. The clinical signs of its poisoning appear within six hours in ruminants after ingestion. The clinical symptoms include tachycardia, circling, tremors of the hind limbs, tachycardia, bloat, convulsions, coma and death. This study shows the toxicity in different zero-grazed dairy cattle herds that were fed on Napier grass contaminated with *nicandra physalodes*. The toxicity of aqueous extracts of various parts of plant *nicandra physalodes* was studied in mice. The aqueous extracts of the whole plant included its fruits also was given intra-peritoneal injection (i.p.), its 24 hour median lethal dose (LD50) was determined in white Swiss mice and found to be 1820 mg/kg body weight for leaves, 2580 for fruits and 3620 for whole plant. Clinical signs reported are coat, increased respiratory rate, decreased locomotors activity, gasping for air and leaping into the air before collapsing into coma and death appears in mice [23].

#### CONCLUSION

Medicinal herbs are gifted with variety of natural constituents, therapeutic agents as well as active ingredients with different medicinal actions. Traditional uses of natural compounds of plant origin receiving high attention of researchers as generally believed to be safer than the compounds of synthetic origin. Herbal remedies are more effective and can work efficiently without eliciting any adverse effect. Literature survey of this plant *Nicandra physalodes* has been depicted the various facts about this plant including its

pharmacognostical features, its traditional uses as well as its various pharmacological activities that has been already reported. Diuretic antidiabetic and antimicrobial activity on its alcoholic as well as aqueous extract of plant has also been reported. Its *in-vitro* cytotoxic activity has also been reported. It's also used traditionally in Analgesic, anthelmintic, antibacterial, anti-inflammatory febrifuge, increases bodily vigour, contagious disorders, toothache, intestinal pain from worms and impotence. The most interesting thing about this plant is its potent insect's repellent property due to the presence of nicandrenone. In future this plant could be proof very beneficial according to medicinal point of view.

#### REFERENCES

1. Verma V. 2011. *Bombax ceiba* linn: pharmacognostical, phytochemistry, ethanobotany and pharmacology studies. *IPS* .1(1): 62-68.
2. Chaturvedi S, Joshi A. 2011. Pharmacognostical, phytochemical and cardioprotective activity of tamarinds *indica* linn. bark. *ijpsr*. 2(11): 3019-3027.
3. Pradhan P, Joseph L, Gupta V. 2009. *Saraca asoca* (Ashoka): A Review. *jocpr*.1 (1):62-71.
4. Paarakh P. M. 2009. *Ficus racemosa* linn an overview. *Natural product radiance* .8 (1):84-90.
5. Roll D.2008. Ohio Pesticide and Fertilizer Regulation Industrial Vegetation Control Commercial Category 5 A supplemental guide to be used in conjunction with OSU bulletin, C & T Publication. Department of Agriculture. 841-5.
6. Apple of Peru: A New Invasive Weed in Ohio Joel Felix, Douglas Doohan, and Mark Koenig Department of Horticulture and Crop Science and OSU Extension, Ohio State University, Ohio Agricultural Research and Development Center (OARDC) Wooster, OH 44691.
7. Devi P, Meera R, Muthumani P, Ratnaji C. 2010. Evaluation of Alcoholic and Aqueous Extracts of *Nicandra Physalodes* Leaves for Diuretic Activity. *Int. J. Pharm. Biol. Arch*. 1: 331-334.
8. LeRoy G Holm .1997. *World weeds: natural histories and distribution*. John Wiley and Sons. Gardening - 1129 pgs.

9. Ivana R. 2000. Flower anatomy and morphology of *Exodeconusmaritimus* (Solanaceae, Solaneae) and *Nicandra physalodes* (Solanaceae, Nicandreae): importance for their systematic relationships. *IMBIV*. 22 (2): 187-199.
10. Lovey R. Perissé, P.; Molinelli, M.L. 2007. Seed structure and dormancy of *Nicandra physalodes* (Solanaceae). *Seed sci technol*. 35 (3):560-568(9).
11. Bagchi A, Neogi P, Sahai M *et al*. 1984. Withaperuvin E and nicandrin B, withanolides from *Pysalis peruviana* and *Nicandra physaloides*. *Phytochem*. 23: 853-855.
12. Macnicol PK. 1968. Isolation of 6-Hydroxykynurenic Acid from the Tobacco Leaf. *Biochem.J*. 107: 473.
13. Griffiths CR, Watson AA, Kizu H *et al*. 1996. Tetrahydrone lett.; 29: 3207-3208.
14. Nalbandov O, Yamamoto R. T, Fraenkel G. S. 1964. Insecticides from Plants, Nicandrenone, A New Compound with Insecticidal Properties, Isolated From *Nicandra P.J. Agric. Food Chem*. 12 (1). 55-59.
15. Begley M. J. Crombie L, Ham P. J. Whiting D. A. 1972. Terpenoid constituents of the insect repellent plant *Nicandra physaloides*; X-ray structure of a methyl steroid (Nic-3) acetate. *J. Chem. Soc., Chem. Commun.*, 1108a-1108a.
16. Eckart. 2008. Solanaceae and convolvulaceae - secondary metabolites: biosynthesis. Springer –Verlag Bberlin Heidelberg.
17. Kirtikar, K. R. and Basu, B. D. (1982). In 'Indian Medicinal Plants' Volume 3, (2nd Ed) p. 1564, International Book Distributor Dehradun.
18. Abesundara KJ, Matsui T, Matsumoto K. 2004. Alfa-glucosidase inhibitory activity of some Sri Lanka plant extracts, one of which, *Cassia auriculata*, exerts a strong anti-hyperglycemic effect in rats comparable to therapeutic drug acarbose. *J. Agr. Food. Chem*. 52: 2541-2545.
19. Cetto AA, Jimenez JB. 2008. Alfa-glucosidase-inhibiting activity of some Mexican plants used in the treatment of type 2 diabetes. *J. Ethnopharmacol*. 116: 27-32.
20. Stuart A.R, Gulve EA, Wang M. 2004. Chemistry and biochemistry of type 2 diabetes. *Chem. Rev*. 104: 1255-1282.
21. Mann AS, Jain NK, Kharya MD. 2007. Antimicrobial studies of *Nicandra physaloides*. *Nigerian J. Nat. Pro. Med*. 11: 71-74.
22. S P Gunasekera, G A Cordell, N R Farnsworth. 1981. Plant Anticancer Agents XX.\* Constituents of *Nicandra physalodes*. *Planta Med*. 43 (12):389-391.
23. Muthee J K, Mbaria J M, Thaiya A G. Pharmacology and toxicology Acute toxicity of *nicandra physalodes* L Gaertn in cattle and mice. *AJOL*. 33 (1).