

## CYTOLOGICAL AND PHYTOCHEMICAL ASPECTS OF SOLANUM NIGRUM LINN. COMPLEX – A REVIEW

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### ABSTRACT

In the present study the plant *Solanum nigrum L.* complex is studied by referring to the literature already available to find out the gap available in the study. It was clear from the already published work on this plant that ample amount of work has been done on taxonomy, cytology and medicinal properties but a correlation for these properties from Punjab region has been missing from the literature. This has become the area of interest as it could be highly useful to correlate amount of phytochemical compounds which are important for medicinal properties with cytological characteristics. It can help to conclude that which cytotype of this plant is medicinally more useful of the known three cytotypes i.e. diploid, tetraploid and hexaploid cytotypes. From surveying the available work, black nightshade can be concluded to be actually a complex of various cytotypes, of which one or more could be medicinally

more efficient as being better producers of phytochemicals. This fact could be exploited in pharmaceutical industry in future.

**KEYWORDS:** Solanum, Punjab, Black nightshade, Solanine.

### INTRODUCTION

*Solanum nigrum Linn.* is one of the well known herbal medicines used in traditions systems of medicines for treatment of many diseases.<sup>[23]</sup> It is commonly known by the name black nightshade belong to genus *Solanum* is a native plant of Eurasia that was introduced later on in other continents like Americas, South Africa etc.<sup>[5]</sup> Although plant parts of some strains

may be toxic but in case of some edible strains cooked leaves and ripened berries are used as food in some parts of the world and even in traditional medicine systems.<sup>[5]</sup> When we look at the ancient records of this plant we find it from Paleolithic and Mesolithic era deposits found from ancient Britain, hence it was suggested by Edward Salisbury a botanist and ecologist that it belonged to native flora there in Britain before the emergence of Neolithic agriculture. It was the Carl Linnaeus who described the six varieties of this plant in book *Species Plantarum*.<sup>[40]</sup> The nomenclature problems in this section were quite evident because of the unusual variability in this group of plants.<sup>[15]</sup> Later on nomenclatural problems of this group were corrected and proper documentation for different cytotypes was suggested.<sup>[9,10,11,12,18]</sup>

Now, it is a well established fact that diploid, tetraploid and hexaploid forms of *Solanum nigrum L.* are different cytotypes which are now known as different varieties within the species.<sup>[15]</sup>

Habitats of common black nightshade plant include wooded areas, where it grows as herb or perennial shrub that has a short life span. Its height may vary from 30-120 cm, having ovate leaves with toothed or wavy edges. The petiole is showing winged upper portion and is 1-3 cm in length. White recurved petals in flowers with prominent bright yellow anthers are characteristic features of this plant. The berries are black or brown black when mature but in another strain from India it may be of bright orange or red colour when ripe, however berries are green when in young condition.<sup>[32]</sup> Sometime on the basis of morphological features this plant black nightshade is confused with another plant deadly nightshade which is more toxic, but that deadly nightshade plant is *Atropa belladonna* which can be distinguished from black nightshade on the basis of character that berries grow in bunches in black nightshade while they grow singly in deadly nightshade plant.<sup>[30]</sup>

In India systematic study on this plant is carried out previously in various areas, but still there is a need to carry out a comprehensive systematic study of this plant from Punjab region as it is a potential ingredient of many medicines that could pave the way for treatment of many deadly ailments.



**Fig. 1 Whole plant: *Solanum nigrum* L.**



**Fig. 2 Flowers: *Solanum nigrum* L.**



**Fig. 3 Fruits: *Solanum nigrum* L.**

## **DISCUSSION**

### **Taxonomic classification**

Division: Embryophyta

Sub-division : Angiospermae

Class : Dicotyledonae

Order : Tubeflorae

Sub-order : Solanales

Family : Solanaceae

Genus : *Solanum*

Species : *nigrum*

### Cytotypes

Extensive studies on chromosome number of the plant *Solanum nigrum* L. has been done throughout the world in different regions like three cytotypes have been observed from China.<sup>[39]</sup> West Java, Netherlands.<sup>[14]</sup> Australia.<sup>[36]</sup> Besides that extensive work is also done from India by various workers.<sup>[34,6]</sup> These studies suggest that three different cytotypes of this plant have been observed in India which are diploid, tetraploid and hexaploid. Their main characteristics and identification keys as adopted.<sup>[15]</sup> are discussed as follows:

### Taxonomic key to *Solanum nigrum* L. species from India

- I. Fruits orange-red or yellow, ellipsoid, longer than broad, translucent; corolla lobes rotate; plants short with spreading branches, pedicels deflexed and descending; pollen diameter 25 (21-26)  $\mu\text{m}$ ; chromosome number  $2n = 48$ .....*S. villosum* Mill.
- II. Fruits black, plant erect and tall; corolla lobes stellate.....(ii)
- III. Fruits shiny bluish black; globose, but slightly depressed, 7.5 mm in diameter; seeds small 0.8-1.2 mm long and 0.6-0.9 mm wide. Inflorescence umbelliform, fruiting pedicels pendulous. Flowers small, corolla 5-7 mm diameter. Pollen grain 22 (18-23)  $\mu\text{m}$  across, chromosome number  $2n = 24$  .....*S. americanum* Mill.
- IV. (ii) Fruits dull purplish black, globose, longer than broad, 8 mm in diameter; seeds large 1.3-1.8 mm long, and 1.1-1.4 mm wide. Fruiting pedicels deflexed or descending. Flowers large, corolla diameter 8–11 mm. Pollen grain 30.3 (25.5-31.2)  $\mu\text{m}$  across. Chromosome number  $2n = 72$  .....*S. nigrum* L.

### Diploid Cytotypes

They may be annual or perennial plants that may reach upto 1.0 m height. Leaves along with stems of this plant are usually subglabrous having curved eglandular hairs. The stems are usually green sometimes having purple spots on the nodes. Leaves are oval, simple with wavy or dentate margin, having marginate petiole. Inflorescence is umbelliform type having 3-5 flowers in each group. The nature of pedicel is ascending first then decurved in case of flowers and then it becomes decurved to pendulous in fruits. Calyx is campanulate type which becomes flattened and recurved in fruits. Corolla is stellate in nature with five white petals lobes that may be ovate or triangular in shape. Stigma comes out of the ring of anthers at the tip. The anthers being 1.05 (0.9-1.2) mm long. The fruit when matures becomes bluish black in colour with shiny surface and diameter of 7.5 (5.0-8.1)mm, each having 35-55 seeds.

Pollen grain diameter in these plants is 22 (18-23)  $\mu\text{m}$ . Chromosome counts to  $2n=24$ . These plants are commonly found in temperate or tropical climatic regions on waste lands.

### **Tetraploid Cytotypes**

These plants are usually annual but may be perennial with short life span. Their appearance becomes bushy with age as they have ascending branches and are 0.5 m tall. The stems and leaves are having eglandular hairs which are curved and stem is subglabrous. Colour of leaves may be green to purple green with ovate shape and acuminate tip. The margins of leaves are regularly toothed. Extra axillary racemiform inflorescence is present consisting of 4-6 flowers each. When anthesis occurs the corolla tube becomes reflexed. Calyx shows campanulate condition and it becomes reflexed in fruit. Usually the lobes of calyx are triangular. Corolla shows rotate aestivation, white in colour and triangular shaped lobes. Anthers are  $1.26\pm 0.11$  mm long, pollen 25 (21-26)  $\mu\text{m}$  across. Stigma is not protruded out of the ring of anthers but it is present at the same level with the anthers. Mature fruit shows ellipsoid shape having more length than breadth. The fruits are 6.3 (5.0-7.5) mm, in size with orange-red colour and seeds 38 (20-40) in number. Chromosome number is  $2n=48$  showing its probable tetraploid nature. It is commonly found in tropical or temperate regions growing well on the waste lands.

### **Hexaploid Cytotypes**

They are tall and erect plants usually having spreading branches with upto 1.0 m height. The stem colour is purplish green, showing prominent ribs all over and eglandular hairs are present. The leaves show simple lamina with oval or lens like shape having dentate margin. The inflorescence is racemiform type with 6(3-8) flowers and is present extra axillary in position. Campanulate type calyx gets flattened in fruit sometimes gets recurved and show triangular lobes. The corolla appears stellate or star like with ovate lobes. Pedicel is decurved to ascending in flower which becomes pendulous to decurved in fruit. Fruits show purplish black colour showing diameter of 7.9 (7.0-9.5) mm, with 40(25-60) seeds in one fruit. The anthers are having length of 1.9 (1.8-2.0) mm showing stigma slightly protruding out from the tip of anther ring. The diameter of pollen grain is 30.3 (25.5-31.2)  $\mu\text{m}$ . Chromosome count in this cytotype is  $2n=72$  indicating its hexaploid nature. They are restricted to temperate climatic regions and are not found in tropical regions.

### Phytochemical Study

*Solanum nigrum* L. being a plant of pharmacological interest is known to be having many phytochemical compounds of medicinal importance.<sup>[27]</sup> It is specially known for a toxic compound found in unripened berries in highest concentration, the solanine which is a glycol alkaloid compound.<sup>[8]</sup> Due to presence of a large number of phytochemical compounds, it is used in many traditional Indian medicines. These medicines are used in dysentery, fever, ulcers, tuberculosis, skin diseases and in various complaints of stomach. It's fruits are used for stimulating appetite and in treatment of asthma and thirst. It is used in North India in the form of boiled extracts of berries and leaves for problems related to liver and even jaundice.<sup>[22,23,29,35]</sup>

The phytochemicals that are obtained from different parts of this plant were reported by many workers, however the two compounds solanine and solasodine whose chemical structure is as represented in figure 4 and 5, are most commonly found in extracts of this plant. Here the solasodine is reported to be showing salinity dependent production as given by.<sup>[7]</sup>

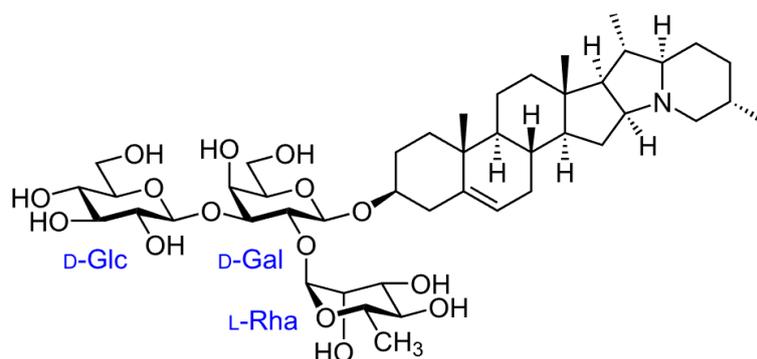


Figure 4: Solanine.

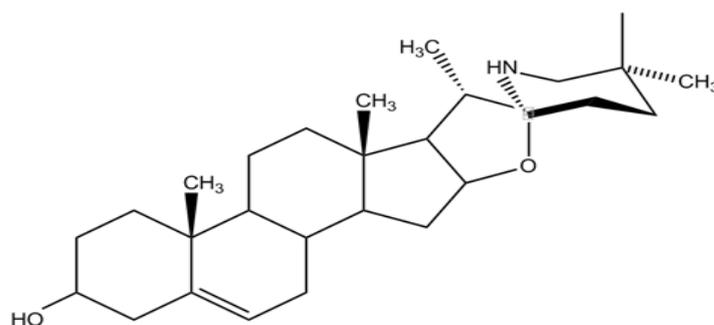


Figure 5: Solasodine.

The details of various phytochemicals that have been isolated from *Solanum nigrum* L. have been given in table 1 along with their references.

**Table 1: Phytochemicals that are obtained from *Solanum nigrum* L.**

S. No.	Phytochemical name	Reference
1	Solanine	[5]
2	Solasodine	[7,13]
3	Beta-2-solamargine	[21]
4	Solamargine	[21]
5	Degalactotigonine	[21]
6	Solanigrosides (group of six saponines)	[41]
7	Nigrumin I and Nigrumin II	[38]
8	Systemin	[24]
9	Quercetin	[31]
10	Tigogenin	[37]

Besides the above given phytochemicals various nutrient contents were reported from *Solanum nigrum* L. which include many nutritive components inspite of presence of anti nutritive components like oxalate. The plant parts contain proteins (24.90%), ash (10.18%), crude fibers (6.81%) and carbohydrates (55.85%) as reported by Atanu et. al. 2011. Besides these nutrients there are many minerals in the order of their abundance in leaves as Mg > K > Ca > Fe > Na > Mn > Zn and similarly the vitamins contents reported from leaves are in the order Vit.C > Vit. B. > Folic acid > Vit. E > Vit A. Cyanide levels are found to be higher in leaves as compared to seeds.<sup>[5]</sup>

As a large number of phytochemicals, nutrients, minerals and vitamins are reported from various parts of the plant, so the medically important properties related to them are reported by many workers. Some of the properties of this plant along with their references are as given below in the table 2.

**Table 2: Medicinal properties of extracts of different plant parts of *Solanum nigrum* L.**

S.No.	Part of plant used	Property	Extract preparation	References
1	Root, fruits	Anti cancer	Crude polysaccharide	[4,16]
2	Roots	Immunomodulatory	Ethanollic extract	[16,28]
3	Leaves	Immunostimulant	Aqueous and methanolic extracts	[3]
4	Roots	Antimicrobial	Ethanollic extracts	[5,16]
5	Roots	Nematicidal	Ethanollic extracts	[5]
6	Roots	Molluscicidal	Ethanollic extracts	[2,16]
7	Roots, Leaves	Antioxidant	Ethanollic extracts	[1,3,16,20,26]

8	Roots	Anti-convulsant	Crude polysaccharide	[33,38]
9	Roots, Leaves	Hepatoprotective	Ethanollic extract, aqueous and Methanollic extracts	[3]
10	Roots, Leaves	Antiulcerogenic	Aqueous extract	[17]
11	Leaves	Antigastritis	Aqueous extract	[17]
12	Roots, leaves	Anti inflammatory	Ethanollic and Methanollic extracts	[16,23]
13	Roots	Hypotensive	Ethanollic extracts	[27]
14	Leaves	Analgesic	Ethanollic extract	[25]
15	Leaves	Cytotoxic	Ethanollic extract	[16]

## CONCLUSION

The conclusion from the above discussion about the taxonomical features of the plant is that there exist three cytotypes of the plant which leads to occurrence of changes in morphological features of the plant, and it also in turn may have bearing upon many other vital characteristics or medicinal properties of the plant hence it is necessary to pay attention to characteristics of different cytotypes of the plant.

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