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AN UPDATED REVIEW ON MOLECULAR GENETICS, PHYTOCHEMISTRY, PHARMACOLOGY AND PHYSIOLOGY OF BLACK NIGHTSHADE (*SOLANUM NIGRUM*)

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ABSTRACT

This article reviews, connected the gap between the folkloric use of *Solanum nigrum* and the results of evidence based experiments. Although *Solanum nigrum* is a rich source of one of plants most dreaded toxins solanine, it has appreciably monstrated its potential as a reservoir of antioxidants having hepatoprotective, anti-tumor, cytostatic, anti-convulsant, anti-ulcerogenic and anti-inflammatory.effects. The review encompasses *in-vitro*, *in vivo* and clinical studies done on *Solanum nigrum*, while examining.whether or not correct scientific measures have been taken in generating experimental evidences for its traditional uses. This review would afford research scientist to know how much is known and what is left undone in the investigation of *Solanum nigrum*. The compounds considered in this revieware flavonoids and other phenolics, alkaloids (especially indole terpenoid and purine alkaloids), essential oils and other terpenoids, cannabinoids, lucosinolates and isothiocyanates, and compounds having human hormone activity. The review concludes with a discussion of the possible evolutionary mechanisms that have led to the evolution of UV-B regulation of secondary metabolite accumulation. Many Ayurveda philosophers and healers praised about the properties of this plant and utilized in various disorders. Here, a review made on the screening of *Solanum nigrum* for various activities. It is found that the drug is very potential and can be used for various applications as mentioned in Ayurveda. Black nightshade grows as a weed, found in the dry parts of India and other parts of the world. It has a medicinal usage and has been used as a traditional folk medicine for treating various ailments such as pain, fever and liver disorders. Generally, black nightshade is very rich in nutritive values, which are capable of supplying minerals, vitamins, hormones and proteins. This herb elaborates a wide variety of medicinal properties such as anticancer, antioxidant, neuroprotective, cytoprotective, antimicrobial, antinociceptive and antipyretic properties.

INTRODUCTION: Nature has provided a complete store-house of remedies to cure all aliments of mankind. This is where, nature provides us drugs in the form of herbs, plant and algae's to cure the incurable diseases without any toxic effect [1]**.** *Solanum nigrum* European Black nightshade or locally just (black nightshade). A species in the *Solanum* genus, native to Eurasia & introduced in the America, Australasia &

South Africa [2]. The *Solanum nigrum* complex also known as *solanum L* is group of *Solanum* species with general black nightshade characteristic. The *Solanum* species in this group can be taxonomically confused, more-so by intermediate forms and hybridization between the species [1].

*Solanum incanum, Solanum nigrum (Solanaceae)*in the plant family *Solanaceae* (night shadow plant) the genus *solanum* is very large group of about 1400 species found throughout in the temperate and tropical region of the world like *Solanum aviculare* (Europe, New Zealand), *S. dulcamara* (Europe), *S. incanum* (Africa), *S. khasianum* (India subcosmopolite), *S.laciniatum* (New Zealand,Australia*), S.nigrum* (cosmopolite*), S.pseudocapsicum*(an ornamental, cultivated in greenhouses*), S. tuberosum* (potato) and *S. melongena* (eggplant, aubergine) [3].

Black nightshade is a fairly common herb or short-lived perennial surb found in many wooded areas as well as disturbed habitats. It has a hight of 30-120 cm, leaves 4-7 cm and 2-5 cm wide long with a winged upper portion. The flowers have petals greenish to whitish, recovered when aged and surround prominent bright yello anthers. The berry is mostly 6-8 mm diameter dull black or purple-black in India [4]. The toxicity of *Solanum nigrum* varies widely depending on the variety and poisonous plant experts advise" unless you are certain that the berries are from an edible strain leave them alone [5]. All parts of plant can be poisonous, containg toxic glycoalkaloids at 0.524% (dry weight) [6].

The toxins are most concentrated in the unripe green berrie [7, 6]. Poisoning symptoms are typically delayed for 6 to 12 hours after ingestion [7]. The solanine in *Solanum nigrum* is not destroyed during normal cooking because the decomposition temperature of solanine is about 243 C [8].

Several compounds have been isolated from different fractions of *S.nigrum* which have shown pharmacological relevance to the observed effects of whole plant preparation of *S.nigrum*. Acetic acid, tartaric acid, malic acid and citric acid were identified as the major organic acids in *S.nigrum* [9]. Tartaric acid and citric acid however, were said to be most important in adaptive responses by *S. nigrum* to environmental stresses.

High concentrations of solanine, a glycoalkaloid is found in most parts of Sn, but highest levels are found in unripe berries of *S. nigrum*. However, when ripe, the berries are the least toxic part of the plant and are sometimes eaten without ill effects. Similarly, the solanine increases in the leaves as the plant matures. The absolute amount of alkaloid per leaf increased during leaf development, whereas, the concentration declined. Small unripe fruits of *S. nigrum* had a high concentration of solasodine, but both the concentration and the absolute amount per fruit decreases with fruit maturation [10].

Studies on *S. nigrum* through spectroscopic analysis, chemical degradation and derivitisation led to the identification of six new steroidal saponins collectively called solanigrosides and a one known saponin degalactotigonin [11]. The effect of crude polysaccharide isolated from *S. nigrum* linn. (SNL-P) was examined both *in vivo* and *in vitro* on U14 cervical cancer cells [12]. This can also be considered as the basis for its use as an anticancer agent [13].

Consequently, the need for potent antioxidants in our diet and drug supplements becomes very necessary. A study which utilises six pretreatment methods before cooking on the peroxidase activity, chlorophyll and antioxidant status of *S. nigrum* L, sharp difference in the carotenoids, phenolics, flavonoids and tannins contents has been reported, indicating the fragility of this antioxidant present in *S. nigrum* [14]. This is an herbal plant that has been used as hepatoprotective and anti-inflammatory agent in Chinese medicine [15]. Central nervous system-depressant action of *S. nigrum* was ascertained by measuring the effects of intraperitoneal injection of *S. nigrum* on various neuropharmacological parameters [16].

Their biosynthesis has also been implicated in the pathophysiology of cardiovascular diseases, cancer, colonic adenomas and Alzheimer's [17].

In Ethiopia, the ripe berries are picked and eaten by children in normal times, while during famines all affected people would eat berries; it is used as a food source until their crops are ready [18]. The Welayta people in the nearby Wolayita Zone do not weed out *S. nigrum* that appear in their gardens since they likewise cook and eat the leaves [19].

In South Africa, the very ripe and hand-selected fruit (nastergal in Afrikaans and umsobo in Zulu) is cooked into a beautiful but quite runny purple jam [20]. The plant has a long history of medicinal usage, dating back to ancient Greece. It was a traditional European medicine used as a strong sudorific, analgesic and sedative with powerful narcotic properties [21]. Internal use has fallen out of favor in Western herbalism due to its variable chemistry and toxicity, but it is used topically as a treatment for herpes [22].

S. nigrum is an important ingredient in traditional Indian medicines. Infusions are used in dysentery, stomach complaints and fever. The juice of the plant is used on ulcers and other skin diseases. The fruits are used as a tonic, laxative, appetite stimulant; and also for treating asthma and "excessive thirst" [23]. Traditionally the plant was used to cure tuberculosis [24].

In North India, the boiled extracts of leaves and berries are also used to alleviate liver-related ailments, including jaundice. In Assam, the juice from its roots is used against asthma and whooping cough [25]. *S.nigrum* is a widely used plant in oriental medicine. It is antitumorigenic, antioxidant, anti-inflammatory, hepatoprotective, diuretic, and antipyretic [26].

Plant Molecular biology, tissue culture and physiology of *Solanum nigrum*: *Solanum nigrum* found in different forms and different metheod used by many scincetist in this process. The psbA gene coding for this protein was cloned from *Solanum nigrum* atrazine-susceptible ('S') and atrazine-resistant ('R') biotypes. Non-silent change in psbA in different 'S' and 'R' weed biotype pairs suggests a functional, herbicide-related role for this codon position [27]. The *psbA* gene cloned in *pSB135* from *Solanum nigrum* atrazine-resistant biotype was sequenced [28].

Another study results demonstrate the existence of a marked antagonism between physicochemical stresses, with water stress enhancing the resistance of photosystem II to constraints (heat, strong light at high temperature) that are usually associated with drought in the field [29]. The open reading frame and terminator region of a wound-inducible tomato Inhibitor I gene, regulated by the CaMV 35S promoter, was stably integrated into the genomes of nightshade *(Solanum nigrum),* and two other plants using an Agrobacterium-mediated transformation system. The results of these experiments suggest that maximal expression of foreign proteinase inhibitor genes, and perhaps other foreign defense genes, may require gene constructs that are fashioned with promoters and terminators that allow maximum expression in the selected plant species [30].

A wound-inducible proteinase Inhibitor I gene from tomato containing 725 bp of the 5' region and 2.5 kbp of the 3' region was stably incorporated into the genome of black nightshade plants *(Solanum nigrum)* using an Agrobacterium Ti plasmid-derived vector. The results demonstrate that thegene contains elements that can be regulated in a wound-inducible, tissue-specific manner in nightshade plants[31].

Some scincetist study based on Suspension cell cultures of *Solanum nigrum* were grown in the presence of six different chloroplast DNA synthesis inhibitors. These results suggest that DNA gyrases participate in cpDNA replication [32]. A number of *Solanum nigrum* mutants resistant to the antibiotics spectinomycin, streptomycin and lincomycin have been isolated from regenerating leaf stripsafter mutagenesis with nitroso-methylurea.The value of these mutants for studies on plastid genetics is discussed [33].

Efficient plastid transformation has been achieved in *Nicotiana tabacum* using cloned plastid DNA of *Solanum nigrum* carrying mutations conferring spectinomycin and streptomycin resistance. It is a diminished mismatch, recombination/repair system in higher-plant plastid[34]. In protoplast-derived *Solanum nigrum* microcalluses, plasmodesmal connectivity and cell division behaviour of the sister cells were examined by repeated pressure-injection experiments with the fluorescent dye Lucifer Yellow (LYCH; M (r) 457) and concomitant light-microscopical long-term live observations.

The results are discussed with respect to the possible role of plasmodesmata in exerting "supracellular control" over mitotic activity by trafficking mitosis-regulating signals [35]. Reactive oxygen species (ROS) production, peroxidase activity and lipid peroxidation have been studied in the CF-treated cell suspensions derived from leaves of the resistant *S. Nigrum*

(nonhost) and *S. tuberosum cv. Bzura* as well as from the susceptible *S. Tuberosum cv*. They suggest that lack of stringent control of the oxidative processes and sensitivity to the pathogen toxins may be decisive for limited polygenic resistance in potato [36].

Many scientist studies were based on *Solanaceae* family plant *S.nigrum* and other plant species. They were demonstrated that transgenic Lotus plants producing opines (which are small amino acid and sugar conjugates) specifically favour growth of opine-degrading rhizobacteria [37]. They suggest that Piper extracts could be used effectively as contact botanical insect control agents to protect potato plants from developing *L. decemlineata* larvae at concentrations less than 0.1%. There is also potential for Piper extracts to control insecticide resistant populations in conjunction with other integrated pest management (IPM) strategies used in conventional and organic agriculture [38].

In breeding for resistance to late blight, (Phytophthora infestans Mont. De Bary), an economically important disease affecting potatoes, the search for new sources of durable resistance includes the non-host wild *Solanum* species. The results confirm the effective transfer of late blight resistance of *S. nigrum* into its somatic hybrids with potato [39]. Previous studies have shown that suspension-cultured cells of *Solanum* genotypes with various polygenic resistances to Phytophthora infestans differed in activities of early oxidative processes in response to culture filtrate (CF) from this pathogen. The relative increase in the ROS production was higher in the susceptible clone H-8105 than in both resistant genotypes. Lipid peroxidation increased only in the nonhost *S. nigrum*.

The present results suggest that the involvement of both ROS production and LOX activity in the defense strategy in *Solanum* species/*P. infestans* interactions [40]. Tomato plastid transformants were obtained using two vectors containing cloned plastid DNA of either *Nicotiana tabacum* or *Solanum nigrum* and including point mutations conferring resistance to spectinomycin and streptomycin. Transformants were recovered after PEG-mediated direct DNA uptake into protoplasts, the results demonstrate the efficacy in tomato of a selection strategy which avoids the integration of a dominant bacterial antibiotic resistance gene [41].

Some scientist of the study based on different plant species for different techniques used in this process. Based on the photosynthesis-light response equation, the theoretic light compensation point of *L. serriola* was 37.58 micromole m (-2) x s(-1), its theoretic light saturation point was 1 rate of *L. serriola* were leaf photosynthetic active radiation,stomatal [42].

They extend Ryan's seminal work on the 18-amino acid polypeptide systemin in tomato's *(Solanum lycopersicum)* systemic wound response to the closely related solanaceous species *Solanum nigrum* [43]. The influence of the acetolactate synthase inhibitor metsulfuron-methyl on the operation of the photosynthetic apparatus was examined on 4-weeks-old climate chamber-grown *Solanum nigrum* plant. To have an indication on the relative performance of the photosynthetic apparatus of ALS-treated plants Results indicated a progressive inhibition of the level of CO(2) fixation, the relative quantum efficiency of photosystem I (Phi(PSI)) and II (Phi(PSII)) electron transport and the leaf chlorophyll content already 2 days after application of the herbicide [44].

This study based on the technology of obtaining the tobacco plants possessing the hereditary changes in the photosynthesis pigments accumulation during development using exogenous DNA has been elaborated *(Solanum nigrum L.)* These plants have simultaneously the useful features--accelerated development, early blooming phenotype and higher productivity. Possible mechanisms emphasized such inherited biochemical changes have been discussed [45].

The team of scincetist study on the analysis of the structure and functional relationship was carried out by docking of the beta-(1, 3)-glucan onto the acidic cleft region on the surface of the protein (SniOLP) [46]. The initial phase of the lipid peroxidation process in leaves of *Solanum nigrum* var. gigantea, *Solanum tuberosum* CV Bzura and clone H-8105, which represent non-host resistance, field resistance and susceptibility, respectively, against Phytophthora infestans, was investigated. The obtained results are discussed in light of the overall biochemical cell status of plants in the studied interactions [47]. Heterologous protein expression in microorganisms may contribute to identify and demonstrate antifungal activity of novel proteins.

The *Solanum nigrum* osmotin-like protein (SnOLP) gene encodes a member of pathogenesis-related (PR) proteins; it represents a novel PR-5 protein with promising utility for biotechnological applications [48]. The present study is intended to determine metabolites of 12 dichlorinated, seven trichlorinated, five tetrachlorinated and one entachlorinated PCB congener transformed by black nightshade *(Solanum nigrum)* hairy root culture SNC-9O. Only traces of metabolites were found in sporadic cases, so exudation of unbound biphenylols from the cells is not expected [49].

Many scincetist study based on *S.nigrum* plant species.Gibberellins (GAs) are endogenous hormones that play a predominant role in regulating plant stature by increasing cell division and elongation in stem internodes. The product of the GA 2-oxidase gene from *Phaseolus coccineus* (PcGA2ox1) inactivates C (19)-GAs. The PcGA2ox1 gene was introduced into *Solanum melanocerasum* and *S. Nigrum (Solanaceae)* by Agrobacterium-mediated transformation with the aim of decreasing the amounts of bioactive GA in these plants and thereby reducing their stature [50].

Various in vitro grown tissues (non-regenerative callus, regenerative callus and microshoot derived leaves) of *Solanum nigrum L.* were cultured under salinity stress (0-150 mM NaCl) for enhanced production of solasodine, a steroidal alkaloid and an alternative to diosgeninThe proposed HPTLC method showed a good linear relationship (r^2=0.994) in 50-2000ng/spot concentration ranges. The data demonstrate that the solasodine production in cultures was growth dependent [51]. By using genetic transformation of Agrobacterium rhizogenes and liquid culture, The results showed that hairy roots could be initiated from the cut edges of leaf explants 5 days after inoculation with the strain of *A. rhizogenes* ATCC15834. The results presented here had provided the possibilities on how to prepare optimum medium for large scale cultivation and production of solasodine from *S. nigrum* L. var. pauciflorum hairy roots [52].

Solanaceaeous taxa produce diverse peptide serine proteinase inhibitors (SPIs), known antidigestive defenses that might also control endogenous plant proteases. While the defense against herbivores specialized on SPI-rich diets requires other unknown defense mechanisms [53]. Fertilizer amendments can impact weed populations in a variety of ways. Compost is a promising tool for incorporation into integrated weed control strategies aimed at reducing weed seed bank persistence [54].

This study based on naturally selected atrazine-resistant (AR) weeds possessing a Ser(264) --> Gly D1protein en coded by a mutant psbA allele in the chloroplast-DNA have increased photosensitivity and lower fitness. Suggesting that the evolutionarily conserved D1 structure must be indispensable for the efficient NPQ process in higher plants [55]. The tomato red spider mite Tetranychus evansi Baker ET Pritchard occurs on *solanaceous* plants, and causes serious damage to a variety of crops in Africa and Europe. In 2001 this species was also found in Japan, on nightshade (*Solanum nigrum L.).* These results indicate that *T. evansi* after invasion into Japan has the potential to become a serious pest on *solanaceous* crops, just the same as in Africa and Europe [56].

Remediation of plant-microorganism-chelates synergy has been proposed as an effective remediation method for enhancing the removal efficiency of heavy metal. The responses of antioxidative enzymes to Cd stress significantly decreased following application of CA and PLNH1, and the oxidative stress experienced by the plant due to Cd in the soil [57]. Premise of the study: Intron Targeting (IT) primers were developed for potato using *expressed sequence tags (EST)* and *NCBI* database records to study genetic diversity. Twenty-nine polymorphic intron targeting (IT) markers were generated and characterized from 30 samples of potato and 22 samples of *Solanum nigrum* to detect polymorphism. The developed markers will provide valuable tools for genetic diversity analysis, genetic mapping, and marker-assisted breeding of potato and related *Solanum* species [58].

Zn tissue accumulation in *Solanum nigrum* grown in a non-contaminated and a naturally contaminated Zn matrix and the effect of inoculation with different arbuscular mycorrhizal fungi (AMF) on metal uptake were assessed [59]. This study was carried out to determine the fungal pathogens on *S.nigrum L*. and other six species is involved in this process. As a result of two year surveys, ten fungal pathogens were determined on eight weed species.

Further studies should be conducted to evaluate the efficacy of this pathogen under in vitro and in vivo conditions [60]. Jasmonates are ubiquitous messengers in land plants essential for the activation of defense responses. *Solanum nigrum* plants transformed to silence the expression of key genes in jasmonate production (SnLOX3) [61].

This study based on Black nightshades is a group of species best known for their 'poisonous' or noxious weedy reputation. This high level of novel genomic variability obviously enabled species to succeed in their new environment [62]. Arbuscular mycorrhizal fungi (AMF) are known for their beneficial effects on plants. Our results show that *AMF* can negatively influence the growth of some weed species indicating that *AMF* have the potential to act as determinants of weed community structure, in order to further the practical and ecological relevance of our findings, additional experiments should be performed under field conditios [63].

Gibberellins (GAs) control many aspects of plant development, including seed germination, shoot growth, flower induction and growth and fruit expansion. The results are discussed in the context of regulating plant stature, since this strategy would decrease the use of chemicals to promote plant growth [64].

Ecological and environmental studies: Ecological and environmental studies in different plant species is used, accumulation and endurance of 45 weed species in 16 families the results showed that *Solanum nigrum* and *Conyza canadensis* can not only accumulate high concentration of Cd, but also strongly endure to single Cd and Cd-Pb-Cu-Zn combined pollution. Although there were high Cd-accumulation in *Artemigia selengensis, Znula britannica* and *Cephalanoplos setosum*, their biomass was adversely affected due to action of heavy metals in the soils [65].

Plants respond to environmental stresses through a series of complicated phenotypic responses, which can be understood only with field studies because other organisms must be recruited for their function. Present *Solanum nigrum* L. a *Solanaceous* relative of potato and tomato for which many genomic tools are being developed, as a model plant ecological expression system. Both flea beetle attack and jasmonate elicitation increased proteinase inhibitors and jasmonate elicitation decreased fitness in field-grown plants. Hence, proteinase inhibitors and jasmonate-signalling are targets for manipulative studies [66].

The aim of our investigations was to study the susceptibility of 22 weed species to *Pepino mosaic virus* (PepMV). Seven plants of each species were mechanically inoculated at 4-6 leaf stage with PepMV in a vector free virological glasshouse. Inoculated plants were tested on the basis of symptoms, by DAS ELISA serological method and back inoculation. Among the 22 weed species, Other 18 weed species seemed to be resistant to PepMV, and on the basis of back inoculation not even latent infection has been observed [67].

This study investigated the allelopathic effects of various weeds extracts on seed germination of 11 crop species. Most of the weed extracts tested had inhibitory effects on seed germination of *common bean, tomato, pepper, squash, onion, barley, wheat,* and corn at different application rates as compared with the 10% acetone control. It was concluded that some of the weed extracts tested in this study could be used as inhibitor while others could be used as stimulator for the crops [68].

It is main groundwork and the first step of phyto-extraction of its commercial application on a large scale to screen out a series of ideal hyperaccumulators that can effectively remedy contaminated soil by heavy metals, A cadmium-hyperaccumulator *S. nigrum* L. (weed) was first discovered by using the pot-culture method arranged in outdoor and sampling-analyzing experiments carried out in heavy metal contaminated areas [69].

The influence of different cadmium concentrations on the organic acid level in leaves of the Cd hyperaccumulator, *S. nigrum* L. in particular the relationship of organic acids with Cd accumulation in *S.nigrum* was investigated based on the pot-culture experiment. These results indicated that tartaric, acetic and citric acids in leaves of *S. nigrum* might act as the indication of Cd hyperaccumulation [70]. *S. nigrum* was found to proliferate in sediments with high levels of metal pollution.

The effect of Zn on plant growth and tissue metal accumulation was assessed. The response of the plant to the inoculation with four different isolates of arbuscular mycorrhizal fungi (AMF) (Glomus sp. BEG140, Glomus claroideum, *Glomus mosseae* and *Glomus intraradices*) was studied [71].

This study based on allelopathic effect of *Ageratum conyzoides* L. *Cynodon dactylon* (L.) Pers. *Parthenium hysterophorus* L. *and Solanum nigrum* L. were examined on seed germination, seedling growth, total protein content and protein profile on Ankur, Bhatt, Bragg, PK -416, PS-1042 and Shilajeet varieties of soybean (*Glycine max* (L) Merill). The order of susceptibility of different varieties with different weed extracts followed the order: Ankur > PK-416 > Bhatt > Shilajeet > Bragg and > PS-1042 [72].

The plant species composition and their ability to accumulate heavy metals were investigated at three contaminated sites in Xiangxi area, Southern China. The concentrations of Cd, Pb, Zn, and Cu in more than 363 samples of 125 plant species were analyzed in the present study. Such as *Kalimeris indice* (L.) *Sch.-Bip*. and *Solanum nigrum* L. might be suitable for use in the phytoextraction of contaminated soils.

The dominant and relative dominant species with low accumulation of metals and dense fibrous root systems, such as *Imperata cylindrical* (L.) *Beauv. Var*. major *C. E.* and *Miscanthus floridulus* (Labill.) Warb. Might be suitable for stabilizing such metal contaminated sites [73].

The behaviour of the organochlorine pesticide hexachlorocyclohexane (HCH) is investigated. The concentrations of alpha-, beta-, gamma-, and delta-HCH isomers were measured in soils, rhizosphere and vegetation in a contaminated area in Galicia (NW Spain). The total concentration of HCH in soils reached values close to 20,000 $mgkg^{-1}$.

The plants analysed *(Avena sativa L. Chenopodium spp. Solanum nigrum* L. *Cytisus striatus* (Hill) Roth and *Vicia sativa* L.) accumulated HCH, especially the beta-HCH isomer; in their tissues tend to reduce levels of the HCH isomers in the rhizosphere. The results reflect the importance of vegetation in the distribution of organochlorine compounds in thesoil-plant system [74].

This study based on six new steroidal saponins, solanigrosides C-H (2-7), and one known saponin, degalactotigonin, were isolated from the whole plant of *Solanum nigrum.* Their chemical structures were elucidated using spectroscopic analysis, chemical degradation, and derivatization. All seven compounds were tested for their cytotoxicity using four human tumor cell lines (HepG2, NCI-H460, MCF-7, and SF-268). Only compound 1 was cytotoxic, with IC50 values of 0.25-4.49 microM [75].

Desmedipham, phenmedipham and a 50% mixture of the two decreased the maximum quantum efficiency of photosystem II (F (v)/F (m)) and the relative changes at the J step (F (VJ)) immediately after spraying in both sugar beet and black nightshade grown in the greenhouse. The differential speed of herbicide metabolism between weed and crop plays an important role in herbicide selectivity and can be studied by using appropriate chlorophyll a fluorescence parameters [76].

Topramezone is a new, highly selective herbicide of pyrazole structure for the post-emergence control of broadleaf and grass weeds in corn. The biokinetic properties and mode of action of topramezone were investigated in plants of *Setaria faberi* Herrm, *Sorghum bicolor* (L.) Moench, *Solanum nigrum L*. and the crop species corn (*Zea mays* L.). Within 2-5 days after treatment, topramezone caused strong photo-bleaching effects on the shoot, followed by plant death of sensitive weeds. A more rapid metabolism combined with a lower sensitivity of the 4-HPPD target enzyme contributes to the olerance of corn to topramezone [77].

Hyperaccumulators are ideal plant species used for phytoremediation of soils contaminated by heavy metals. A full understanding of metal tolerance mechanisms of hyperaccumulators will facilitate enhancing their phytoremediation efficiency when exposed to a higher Cd level (48 mg kg^{-1}), growth and most N metabolism indicators were reduced significantly [78]. The effect of two different chelating agents [EDTA and EDDS (S, S-ethylene diamine-dissucinic acid)] on Zn tissue accumulation in *Solanum nigrum L*. grown in a naturally contaminated soil was assessed.

Under those conditions, addition of chelating agents did not seem to have an effect on the localisation of accumulation sites. The devise of a chelate-enhanced phytoextraction strategy, using chelating agents and AMF, is discussed [79].

In this study based on the phytotoxic and antimicrobial properties of olive mill wastes have been widely investigated and demonstrated over the past decade. The study shows the high potential of naturally occurring chemicals present in TPOMW and TPOMW composts that should be further investigated as bio-pesticides for their use in sustainable agricultural systems [80]. Zn accumulation in *Solanum nigrum* grown in naturally contaminated soil in the presence of different types of organic amendments was assessed. *S. nigrum* grown in the non-amended soil always presented higher Zn accumulation in the tissues [81].

After simulated herbivory, inflicted by a treatment involving wounding and the application of Manduca sexta oral secretions (OS) to mechanical wounds (OS-elicitation), transcripts of the systemin-precursor, prosystemin, are down-regulated in black nightshade *(Solanum nigrum).* That down-regulation of systemin after herbivory is associated with increased root allocation which allows plants to more effectively compete with conspecifics and may allow plants to compensate for tissue losses during herbivory [82].

Application of synthetic chelates such as ethylene diamine tetraacetic acid (EDTA) has been proposed as an alternative technology for phytoextraction of contaminated soils. In a pot experiment, the effects of EDTA application at three growing stages on growth and Cd uptake and accumulation of *Solanum nigrum L*. Were investigated. The results indicated that moderate rate of EDTA applied at the flowering stage would be important to enhance phytoremediation efficiency in practice [83].

This study based on *Solanum nigrum* is a newly discovered Cd-hyperaccumulator. In the present study, the protective effects of proline against cadmium toxicity of callus and regenerated shoots of *S. nigrum* are investigated based on a high frequency in vitro shoot regeneration system.

The interaction between proline and enzymic or non-enzymic antioxidants is discussed [84]. Study on dye-sensitized solar cells (DSSCs) with extracts of *Canna indica* L. *Salvia splendens*, *Solanum nigrum* L. as sensitizer is firstly reported in this paper. DSSCs were assembled by using natural dyes extracted from *C. indica* L., *S. splendens, cowberry and S. nigrum* L. as sensitizers. The electrochemical impedance spectroscopy (EIS) was used to analyze the interface resistance of cells. The result indicated that high resistance [85].

Some scincetist studied that phytoremediation is a promising tool in removing pollutants from the environment or in rendering them harmless. Results showed that iron-deficiency induced cadmium uptake, biomass decrease and changes in pH and Eh in hydroponic culture. Bioconcentration and translocation factors indicated that iron-deficiency status affected cadmium accumulation and translocation in *Solanum nigrum* L. [86].

Cadmium concentrations in two plant species and their corresponding soils were evaluated in a metal contaminated area. The average Cd concentrations reached 36.9 and 141 mg kg^{-1} in *Solanum* nigrum leaves and Lobelia chinensis shoots, respectively. Under the hydroponic culture conditions, the maximum Cd concentration in the *S. nigrum* leaves and L. chinensis shoots were 1,110 and 414 mg kg (-1), respectively. Cd concentration was higher in the roots than in the aerial parts. The two plants may be used in suitable phytoremediation process [87].

Polybrominated diphenyl ethers (PBDEs) are used as additive flame retardants PBDEs are persistent, bioaccumulative and toxic compounds. They are often detected in sewage sludge which is applied on agricultural soils as fertilizer. To our knowledge this is one of the first studies reporting the accumulation of both lower PBDEs and BDE 209 in plants. Our results suggest that absorption, accumulation and trans-location of PBDEs by plants and their transfer to the food chain could represent another possible risk for human exposure [88]. The elevated Cd accumulation in plants in response to salt was found to be correlated with the elevated levels of phytochelatin the expression of heavy metal transporters AtHMA1-4, especially AtHMA4.

Salt alleviated growth inhibition caused by Cd and increased Cd accumulation also was observed in Cd accumulator *Solanum nigrum* [89]. This study based on *S.nigrum L*. a novel technology to obtain highly efficient biosorbent from the endophytes of a hyperaccumulator is reported. Carboxyl, amino, sulphonate and hydroxyl groups on EF LSE10 surface were responsible for the biosorption of cadmium. Copyright (c) 2009 Elsevier Ltd. All rights reserved [90].

To study if *Solanum nigrum* hairy roots can be used for phytoremediation of Cd contamination, we investigated the effects of cadmium (Cd) alone, and in combination with different concentrations of CaCl2, on growth, activities of superoxide dismutase (SOD) and peroxidase (POD) and Cd absorption by hairy roots of *S. nigrum L. var* pauciflorum. The results showed that Cd concentrations of lower than 50 micromole/L enhanced the growth of hairy roots, while higher than 100 micromol/L inhibited growth and decreased the number of branched roots. This was achieved on one hand by reducing the absorption of Cd, on the other hand by decreasing the lipid peroxidation through regulating the activities of antioxidant enzymes SOD and POD in the hairy roots [91].

The effects of cadmium (Cd) on the accumulation of hydrogen peroxide H_2O_2 and antioxidant enzyme. Activities in roots of *Solanum nigrum L.* and the role of N-acetyl-l-cysteine (NAC) as a cysteine (Cys) donor against Cd toxicity were investigated. These results suggest that NAC could protect plants from oxidative stress damage, and this protection seems to be performed via increased GSH biosynthesis. Furthermore, NAC treatment also increased the contents of protein thiols in *S. nigrum* roots [92].

Phytoremediation is a cost-effective, simple and sustainable beneficiary technique to purify the polluted environment. *Solanum nigrum L.* a newly found cadmium (Cd) hyperaccumulator has shown the potential to remediate Cd-contaminated soils. Present study investigated the effects of fertilizer amendments on the Cd uptake by *S. nigrum*. Chicken manure and chicken manure may be a better fertilizer for phytostabilization.2009 Elsevier B.V. All rights reserved [93]. A radiation dose assessment exercise was carried out for the edible biota *Solanum nigrum*, *Carica papaya, Raphnus sativum* and Phaseolus domesticus due to naturally available radionuclides (40) K, (238) U and (232) in the Domiasiat area in Meghalaya, India. Finally compared with the IAEA and UNSCEAR data set for screening level dose risk assessment [94]. Valuable endophytic strains facilitating plants growth and detoxification of heavy metals are required because the application of plant-endophyte symbiotic system is a promising potential technique to improve efficiency of phytoremediation.

In this study, endophytic bacterium LRE07 was isolated from cadmium hyperaccumulator *Solanum nigrum L*. indicating that the endophyte possesses specific and remarkable heavy metal remediation abilities [95]. A well-characterized cadmium (Cd) hyperaccumulating plant *Solanum nigrum* was grown in Cd and polycyclic aromatic hydrocarbons (PAHs) co-contaminated soil that was repeatedly amended with chemicals, including EDTA, cysteine (CY), salicylic acid (Sa), and Tween 80 (TW80), to test individual and combined treatment effects on phytoremediation of Cd-PAHs contaminated soils.These results indicated that *S. nigrum* might be effective in phytoextracting Cd and enhancing the biodegradation of PAHs in the co-contaminated soils with assistant chemicals [96].

In this study, *Solanum nigrum* was used in-situ for Cd phytoremediation in Cd polluted soil on Shenyang Zhangshi Irrigation area (SZIA) in 2008. The results in this paper provide reference values for the future research on the application of *Solanum nigrum L.* in phytoremediation and on chemical or/and agricultural strategies for phytoextraction efficiency enhancement [97]. This study investigates the heavy metal-resistant bacterial endophytes of Cd-hyperaccumulator *Solanum nigrum L.* grown on a mine tailing by using cultivation-dependent technique.

Thirty Cd-tolerant bacterial endophytes were isolated from roots, stems, and leaves of *S. nigrum L*. and classified by amplified ribosomal DNA-restriction analysis into 18 different types [98]. This study based on *S.nigrum* in jasmonate signalling plays a central role in activating the plethora of responses that are elicited by herbivory. *Solanum nigrum* plants silenced in the expression of genes involved in jasmonic acid biosynthesis (irlox3), conjugation (irjar4) and perception (ircoi1) were used to study the function of these genes in the field and in the regulation of

transcriptional and metabolic responses [99]. The effects of *Bacillus* sp. *SLS18*, a plant-growth-promoting endophyte, on the biomass production and Mn/Cd uptake of sweet *sorghum* (*Sorghum bicolor* L.), *Phytolacca acinosa Roxb*. And *Solanum nigrum* L. were investigated. SLS18 displayed multiple heavy metals and antibiotics resistances. This is not only gives a promising phytoremediation strategy but also eases the competition for limited fertile farmland between energy crops and food crops [100].

Pharmacological and Ethanopharmacological aspects: *S. nigrum* and other plant species is involved in this study in a recent survey, 106 local healers in Israel were interviewed concerning the use of *Solanaceae* as medicinal plants. The main findings reveal that the extensive distribution of modern, safe narcotics, sedatives and anaesthetics has reduced the use of the Solanaceae for these purposes [101]. The ethanol extract of the fruit of *Solanum nigrum L. (Solanaceae)* was studied for its neuropharmacological properties on experimental animals. The observations suggest that the fruit of *S. nigrum* possesses potential CNS-depressant action [102].

The preparations of *Solanum nigrum L.* leaves were made on *Biomphalaria alexandrina*. Extract (A), made by soaking leaves powder over night in cold 70% ethanol, has the highest activity, (LC_{50} 3.37 mg/L within 24 hr). This extract also showed larvicidal activity against larvae of two mosquito species, *Aedes caspius* and *Culex pipiens*, (LC_{50} 51.29 and 125.89 mg/L within 24 hr, and 21.38 and 38.11 mg/L within 48 hr, espectively). Sunlight, pH, and turbidity did not affect the activity of this extract, but diluted solutions of this extract lost their activity after four weeks [103].

Allelopathic effect of four plant species were examined on seedling growth of certain commonly used varieties of wheat *(Triticum aestivum L*.) in the Tarai region of U.P. state. The weed extracts inhibited the length of plumule in all the varieties (100%) with *Solanum* and it was in 12 (92%), 10 (77%) and 06 (46%) varieties with *Polygonum, Avena* and *Cyperus*, respectively. On the basis of the present results, UP--2003 and WH--542 followed by PBW--226, Sangam and HD--248 were more susceptible to all the four weed extracts compared to the rest of the varieties of wheat [104].

Nightshade berries containing glycoalkaloids can be a contaminant in green peas. Methodology was developed to detect this contamination. None of the samples contained alpha-solasonine. No unripe berries of *Solanum nigrum* were detected visually in the samples [105].

The present study based on ethnomedicine survey covers the Dharwad district of Karnataka in southern India. It was revealed that 35 plants belonging to 26 families are being used to treat different types of oral ailments like toothache, plaque and caries, pyorrhea and aphthae. Sixteen of these plants were new claims for the treatment of oral ailments not previously reported in the ethnomedicinal literature of India and *Solanum nigrum* are used to treat tooth ache are used in the treatment of plaque and caries [106].

Two main research questions are framing this investigation: the main taxa of the medicinal importance value altered the Showbak forest stand and species composition? The most safe species and what are the toxic ones (unsafe). Obtaining results is relied on the interviewee's personal information and the medicinal use of specific plants [107]. Studies using the medicinal plants enumerated in this study, particularly those with high number of citations and high F (IC) values might yield some novel prototypes. Such studies will also be useful to assess the efficacy and safety of these herbal treatments to take decisions on the health care of rural India [108]**.**

Phytochemical and biochemical studies: Phytochemical studies was performed on bioactivity-guided fractionation, three known steroidal glycosides, beta 2-solamargine, solamargine, and degalactotigonin, were isolated from *Solanum nigrum*. The structures of 1-3 were elucidated on the basis of chemical evidence and spectral analysis, especially by 2D-NMR analysis [109].

Two new steroidal saponins, named nigrumnins I and II, together with two known saponins were obtained from the whole plant of *Solanum nigrum L*. On the basis of spectroscopic analysis (1H-NMR, 13C-NMR, 1H-1H COSY, TOCSY, HMQC, HMBC and FAB-MS), nigrumnin I was established as (25R)-5alpha-spirostan-3beta-ol 3-O-betaD-xylopyranosyl-(1-->3)-[alpha-L-arabinopyranosyl-(1 -->2)]-beta-D- glucopyranosyl-(1--

>4)-[alpha-L-rhamnopyranosyl(1-->2)]-beta-D-galacto pyranoside (1), and nigrumnin II was elucidated as (25R)-3beta,17alpha-dihydroxy-5alpha-spirostan-1 2-one, 3-O-beta-D-xylopyranosyl-(1-->3)-[alpha-L-arabino pyranosyl-(1-->2)]-beta-D-glucopyranosyl-(1-->4)-[alpha-L-rhamnopyra-nosyl-(1-->2)l-beta-D-galacto pyranoside (2) [110].

The importance of the glycolytic flux for the success of Biomphalaria-Schistosome sporocyst interaction was acertained in this study. Hexokinase (HK), pyruvate kinase (PK. Effect of LC_{25} of *Solanum nigrum* leaves dry powder as plant molluscicide on HK, PK and GPI were tested. Treatment with this plant resulted in a significant inhibition of these three investigated enzymes. LC_{10} concentrations of *S. nigrum* reduced considerably the infection rate of B. alexandrina with *S. mansoni* to be 34% compared to an infection rate of 80% in control, non-treated snails [111].

A rapid, easy, and simple spectrophotometric method was developed for the estimation of total alkaloids precipitated by Dragendorff's reagent (DR) in plant materials. It is based on the formation of yellow bismuth complex in nitric acid medium with thiourea. Using this method, in eight plant species is used in this process the alkaloidal percentage of certain alkaloids it can be used for routine analysis of commercial samples by industries dealing with herbal drugs for standardization of plant materials containing alkaloids and for alkaloid-containing pharmaceutical products [112].

Various physiological imbalances lead to reactive oxygen species (ROS) overproduction and/or increases in lipoxygenase (LOX) activities, both events ending in lipid peroxidation of polyunsaturated fatty acids (PUFAs). Besides the quantification of such a process, the development of tools is necessary in order to allow the identification of the primary cause of its development and localization ROS-mediated peroxidation was mainly driven by light and always appeared as a late process [113].

The study on the absorption and accumulation of heavy metals lead, zinc, copper and cadmium by 8 plant species around a smelter showed that the metals accumulation by plants differed with plant species, their parts, and kinds of metals. *Abutilon theophrasti* had a higher capability of absorbing and accumulating Pb. These plants had TF values higher than 1, and were suitable for phytoextraction to remedy polluted soil [114].

Two new pregnane saponins, solanigroside A (1) and solanigroside B (2), along with two known compounds (3 and 4), were isolated from 60% ethanolic extract of the dried herb of *Solanum nigrum L.* on the basis of extensive spectroscopic analysis as well as comparison with reported spectroscopic data of related compounds. This paper deals with the isolation and structural characterisation of pregnane glycosides from *S. nigrum L*. [115].

The separation was performed on the silica gel CC, Sephadex-LH20 CC as well as preparative HPLC. The constituents were isolated and identified by spectral methods. Five compounds isolated from 60% ethanol extract were identified as 6-methoy-hydroxycoumarin (I), syringaresinol-4-O-beta-D-glucopyranoside (II), pinoresinol-4-O-beta-D-glucopyranoside (III), 3, 4-dihydroxhbenzoic acid (IV), p-hydroxybenzoic acid (V), 3-methoxy-4-hydroxyienzoic acid (VI), adenosine (VII) II, III, and VII were isolated from this genus for the first time [116].

In this study carried out investigation some scientist study based on wild vegetables play an important role in the diet of inhabitants of different parts of the world. Among the wild vegetables of South Africa are *Chenopodium album, Sonchus asper, Solanum nigrum* and *Urtica urens*. All the vegetables had comparatively lower concentrations of phytate, alkaloids and saponins [117].

Being able to rapidly and sensitively detect specific enzymatic products is important when screening biological samples for enzymatic activity. The fluorescence and MALDI-TOF-MS signal decrease were associated with the inhibitory effect of the PIs on trypsin. The developed platform can be modified to screen novel protease inhibitors, namely, those potentially useful for treating or preventing infection by viruses, including HIV and hepatitis C [118]. A gene encoding a preprohydroxyproline-rich systemin, SnpreproHypSys, was identified from the leaves of black nightshade (*Solanum nigrum*) and some many other plant species that structural conformations

within the peptides are recognized by the different cells/species to initiate signal transduction pathways, apparently through recognition by homologous receptor(s). To further demonstrate the biological relevance of the SnHypSys peptides, the early defense gene lipoxygenase D was shown to be induced by all three synthetic peptides when supplied to excised nightshade plant [119].

Phytochemical analysis of *Solanum nigrum* has resulted in the isolation of two novel disaccharides. Their structures were determined as ethyl beta-D-thevetopyranosyl-(1-->4)-beta-D-oleandropyranoside (1) and ethyl beta-d-thevetopyranosyl-(1-->4)-alpha-D-leandropyranoside (2), respectively, by chemical and spectroscopic methods [120].

This study based on *Solanum nigrum* L. (SN) has exhibited multiple biological effects such as anti-inflammation and antiproliferation. Protein kinase C (PKC) regulates cellular functions including proliferation, migration, and invasion. In the present investigation, our results revealed the antimigration and anti-invasion effects of both extracts derived from SN, which may act as a promising therapeutic agent for the treatment of hepatocellular carcinoma [121]. To study the chemical constituents from *Solanum nigrum.*Compounds were isolated and purified by silica gel, Sephadex LH-20 and preparative HPLC. Their structures were identified by physicochemical properties and spectral analysis.

Six compounds were isolated and identified as (+)-pinoresinol (I), (+)-syringaresinol (II), (+)-medioresinol (III), scopoletin (IV), tetracosanoic acid (V) and beta-sitosterol (VI). Compounds I - III are isolated from this genus for the first time, while compounds IV and V are isolated from this plant for the first time [122]*. S. nigrum Linn. (Solanaceae),* a traditional Chinese medicine (TCM), has been used for cancer therapy.

It is urgent to develop a novel quality standard to validly detect its quality. To control its quality, a novel, accurate and valid fingerprint method was developed by high-performance liquid chromatography-evaporative light scattering detection (HPLC-ELSD) in the current case. So, in order to get the consistent raw materials, the collecting location and the harvesting time should be fixed [123].

A new method for simultaneous determination of solasonine (1), solamargine (2) and khasianine (3) in *Solanum nigrum* by reversed-phase HPLC was developed. The samples were separated at 30 degrees C on Agilent Zorbax SB C18 (4.6 mm x 150 mm, 5 microm) column with acetonitrile-water-phosphoric as mobile phase. The method is rapid, simple and accurate, and it can be used for the evaluation of *S.nigrum L*. [124]. A new characteristic steroidal glycoside possessing a hydroxyl group at C-23, inunigroside a (1), was isolated from the withered berries of *S.nigrum L*. A new bisdesmoside, 3-O-β-D: -glucopyranosyl-(1→4)-β-D: -glucopyranosyl-(1→4)-β-D: -glucopyranosyl (22R, 25S)-3β, 15α-dihydroxyspirost-5-ene 15-O-α-L: -rhamnopyranoside (4), named jasminoside A, was isolated from the methanolic extract of *S. jasminoides* [125].

Pharmacological and medicinal activities: The team of scientist study based on pharmacological & medicinal activities in this process based on *S.nigrum* and other plant activities .I this study18 plant species, *Solanum nigrum,* was evaluated and discussed. The sensitivity of the keratinophilic fungi was evaluated by dry-weight method [126]. Prosystemin is the precursor protein of the 18 amino acid wound signal systemin which activates systemic defense in tomato leaves against insect herbivores (McGurl B, Pearce G, Orozco-Cardenas M, Ryan CA, Science 255 (1992) 1570-1573).

Here, we report the isolation of cDNA sequences encoding prosystemin from potato *(Solanum tuberosum),* black nightshade *(S. nigrum),* and bell pepper *(Capsicum annuum),* all members of the *Solanaceae* family, using reverse-transcription polymerase chain reaction (RT-PCR). The accumulation of proteinase inhibitor mRNA transcripts could be induced in each of these plants by treatment with the homologous systemin. As in the tomato, in potato, black nightshade, and bell pepper plants, prosystemin homologs appear to function as precursors of systemic wound signals [127].

Ultrastructural effects of AAL-toxin TA from *Alternaria alternata* on black nightshade *(Solanum, nigrum L.)* leaf discs and correlation with biochemical measures of toxicity. In black nightshade *(Solanum nigrum L.)* leaf discs floating in solutions of AAL-toxin TA (0.01-200 microM) under continuous light at 25^{o}C, electrolyte

leakage, chlorophyll loss, autolysis, and photobleaching were observed within 24 h. Electrolyte leakage, measured by the conductivity increase in the culture medium [128]. This study based on *Solanum nigrum L.* leaves and fruits were shown to have molluscicidal activities against snails transmitting schistosomiasis and fascioliasis. Toxicity of plant extracts was also affected by other seasonal dependent factors. These are the duration of plant exposure to direct sunlight and the size of the fruits. *S. nigrum* (black fruits) was more toxic (LC_{50} = 18.1) than the other two types, *S. nigrum, V. vellosum* (yellow fruits) (LC_{50} = 38.9) and *S. nigrum v. juidaicum* (red fruits) (LC_{50} = 34.7) [129].

Squamous cell carcinoma of the esophagus is endemic in parts of South Africa. Previous case-control studies have shown many associations but no clear etiologic pathway has been established. *Solanum nigrum, beans,* and *pumpkin* all contain protease inhibitors. Suppression of protease inhibitors can lead to overexpression of growth factors in the esophagus, resulting in a proliferative and oncogenic drive [130]. The molluscicidal properties of *Solanum nigrum* L. were tested against three Egyptian snail species *(Biomphalaria alexandrina, Bulinus truncatus and Lymnaea natalensis),* each an intermediate host of parasites causing human schistosomiasis or fascioliasis.

The concentrations needed to kill all *cercariae (*LC_{100}) within 30 min of exposure were 30 mg/litre for both *S. haematobium* and *S. mansoni* and 40 mg/litre for *F. Gigantica* [131]. The presence of plant extracts of *Solanum nigrum* and *Cichorium* intybus in the reaction mixture containing calf thymus DNA and free radical generating system protect DNA against oxidative damage to its deoxyribose sugar moiety. These studies suggest that the observed hepatoprotective effect of these crude plant extracts may be due to their ability to suppress the oxidative degradation of DNA in the tissue debris [132].

A study of 100 patients with cancer of the esophagus and 100 controls matched for sex, age, and educational level was done in Transkei, with extensive inquiries into diet and social habits. The significant risk factors found were use of *Solanum nigrum* as a food (relative risk, 3.6), smoking (relative risk, 2.6), and use of traditional medicines (relative risk, 2.1).

Consumption of traditional beer was not a risk factor [133]*. Wistar albino* female rats were maintained for 10 d on diets containing various levels of the vegetable *Solanum nigrum.* Simultaneously, they received daily intraperitoneal injections of aflatoxin B1 (AFB1) (either 0.2 or 0.4 mg/kg body-weight) diluted in propylene glycol. Similar results were obtained with glutathione S-transferase (EC 2.5.1.18) activity which increased by 60% with diet S600 [134].

Antiulcerogenic activities of three plant drugs were studied against aspirin-induced gastric ulcers in rats. The activity may be due to inhibition of acid and pepsin secretions and their in vitro ability to bind these. *Brassica oleracea* (leaf) powder did not affect the ulcer index significantly but its aqueous extract lowered the index. This suggests that its antiulcerogenic effect is due to decreases of acid and pepsin outputs which enhance gastric mucosal strength. The reference drug gefarnate decreased the ulcer index by increasing the hexosamine level only.cimetidine inhibited the acid production but did not decrease the ulcer index [135].

A group of scientist studies based on phytoecdysteroids (agonists) are widely distributed in the plant world, but *solanaceous* species have not been extensively examined for their presence. We have now surveyed 128 species of *solanaceous* plants for the presence of ecdysteroid agonist and antagonist activities using the *Drosophila melanogaster B (II*) cell line bioassay. Each of the phytoecdysteroid-accumulating species examined (*Browallia speciosa, Nierembergia hippomanica var violacea, N*. *solanacea* and *Solanum nigrum)* contain a cocktail of ecdysteroids, of which 20-hydroxyecdysone and polypodine B (5beta, 20-dihydroxyecdysone) are major components [136].

The 50% ethanol extract of the whole plant of *Solanum nigrum* was tested in vitro for its cytoprotection against gentamicin-induced toxicity on Vero cells. Cytotoxicity was significantly inhibited as assessed by the Trypan blue exclusion assay and mitochondrial dehydrogenase activity (MTT) assay. The test extract also exhibited significant hydroxyl radical scavenging potential, thus suggesting its probable mechanism of cytoprotection [137]. Some reschers on studied the susceptibility or resistance of *Solanum capsicastrum* Link. Et Schauer*, S. comatum Sendt, S. dulcamara L, S.*

luteum Mill, S. Malacoxylon Sendt. and *S. nigrum* L. to three aphid transmissible viruses [*alfalfa mosaic alfamovirus (AMV), potato M. carlavirus (PVM)* and *potato S carlavirus (PVS)].* Out of the species, *S. capsicastrum, S. comatum, S*. *dulcamara, S. malacoxylon* and *S. nigrum to AMV, S. capsicastrum* and *S. malacoxylon* to *PVM* and *S. capsicastrum, S. luteum* and *S. nigrum* to PVS showed the highest resistance (immunity). Solanum *comatum* and *S. dulcamara* were susceptible to PVS. Symptoms (necrotic lesions, mosaic and chlorosis) could be seen after inoculation and the absorbance values (DAS-ELISA) exceeded twice that of the healthy control samples during the serological tests [138].

The plant *Solanum nigrum* treated with the pathogen Phytophthora infestans-derived elicitor responded by elevated reactive oxygen species (ROS) production, lipid peroxidation and lipoxygenase activity in comparison with control plants indicating that oxidative stress took place. It is postulated that PQ may be associated with mechanisms maintaining a tightly controlled balance between the accumulation of ROS and antioxidant activity that determines the full expression of effective defence [139].

Somatic hybrids between the cultivated potato diploid hybrid clone, ZEL-1136, and hexaploid non-tuber-bearing wild species *Solanum nigrum L*. exhibiting resistance to Phytophthora infestans were regenerated after PEG-mediated fusion of mesophyll protoplasts. The most vigorous flowering somatic hybrids were selected for assessment of the late-blight resistance [140]. *Solanum nigrum L. (SNL)* has been traditionally used as a herbal plant, whosefruit is believed to have anti-tumor properties, although the mechanism for the activity remains to be elucidated. The *SNL* extract was revealed to be a potential scavenger of hydroxyl radicals and DPPH radicals rather than superoxide anions. Collectively, our findings suggest that *SNL* fruit extract could be used as an anti-oxidant and cancer chemo-preventive material [141].

This study based on the plant *Solanum nigrum* and other plant species is involved in this process and all activities based on the plant and animal species. Alkaline phosphatase (ALP) and total bilirubin. The histopathological changes of liver sample in treated animals were compared with respect to control [142].

Molluscicidial activity of leaves of Acanthus mollis against *Biomphalaria alexandrina* was evaluated. Its petroleum ether extract (LC_{50} values = 6.92 mg/L) was more potent than *Solanum nigrum* and Iris pseudacorus extracts. A binary combination (1:1) of *A. mollis* and *S. nigrum*, as well as, a binary combination (1:1) of A. mollis and I. pseudacorus extracts showed additive effect on snails (24 hr LC_{50}: 5.09 mg/l and 3.76 mg/l respecttively). A tertiary combination (1:1:1) of A. mollis, *S. nigrum* and *I. pseudacorus* extracts (24 hr LC_{50}: 4.01 mg/l) showed good result. Also, petroleum ether extract of *A. mollis* leaves killed Schistosoma mansoni cercariae at concentrations of 20, 10 and 5 mg/l within 30, 45 min. and an hour respectively.

Mortality increased with increasing exposure time and concentration [143]*. Solanum nigrum L. (SNL*) has been traditionally used as an herbal plant for a long time. In the present study, *SNL* glycoprotein showed a dose-dependent radical scavenging activity on radicals, including 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radicals, hydroxyl radical (OH), and superoxide anion (O (2) (-)). When the HT-29 cells were treated with 60μg/ml *SNL* glycoprotein, the cytotoxic effect was induced in a time-dependent manner. More specifically, according to the apoptosis assay, increased as a result of treatment with 40μg/ml *SNL* glycoprotein in a time-dependent manner, whereas they were weakly induced by GO in the cells. Consequently, the *SNL* glycoprotein may induce apoptosis through the inhibition of NF-κB activation, induced by oxidative stress in HT-29 cells [144].

Virus-induced gene silencing (VIGS) has been used routinely in *Nicotiana benthamiana* to assess functions of candidate genes and as a way to discover new genes required for diverse pathways, especially disease resistance signalling. VIGS has recently been shown to work in *Arabidopsis thaliana* and in tomato. Here, we report that VIGS using the tobacco rattle virus (TRV) viral vector can be used in several *Solanum* species,.

Silencing of R1, Rx and RB successfully attenuated R-gene-mediated disease resistance and resulted in susceptible phenotypes in detached leaf assays. Thus, the VIGS system is an effective method of rapidly assessing gene function in potato [145]. This study was carried out to investigate the anticancer effects of a 150-kDa glycoprotein isolated from *Solanum nigrum L.*

(*SNL* glycoprotein) on spontaneously and experimentally induced tumor promotion in HCT-116 cells. For spontaneously induced tumor promotion, dose-dependent cytotoxic and apoptosis-inducing effects at low concentrations. For experimentally induced tumor promotion collectively, these results suggest that *SNL* glycoprotein can induce apoptosis through the modulation of signal mediators. Therefore, we speculate that it could be used as a chemotherapy agent even at low concentrations in HCT-116 cells [146].

Screening was done of some plants of importance in the Ayurvedic system of traditional medicine used in India to treat enteric diseases. Fifty four plant extracts (methanol and aqueous) were assayed for their activity against multi-drug resistant Salmonella typhi. Strong antibacterial activity was shown by the methanol extracts of ten medicinal plants. Moderate antimicrobial activity was shown by *Solanum nigrum* and other herbs of interest [147].

This study was carried out to investigate the modulation of detoxicant enzyme activity and plasma lipidemic levels by 150 kDa glycoprotein isolated from *Solanum nigrum* Linn. (SNL), these results pointed out that *SNL* glycoprotein can enhance the activities of detoxicant enzymes and bring about the inhibition of HMG-CoA reductase activity in vivo. Therefore, we speculate that *SNL* glycoprotein can be used as a cholesterol-lowering agent even at low Concentration [148]. *Solanum nigrum* L. (SNL) has been used in folk medicine for its anti-inflammatory activity. They isolated only the *SNL* glycoprotein from *SNL* and found that it was cytotoxic at low concentration.

The results in this study indicated that SNL glycoprotein induces apoptosis through modulation of PKCalpha and NF-kappaB activity in MCF-7 cells [149]. A crude water extract of *Solanum nigrum* leaves was used as a chemical attenuate to Schistosoma mansoni cercariae prior to infection of Swiss female mice. Cercariae were exposed to 2.5, 5, 7.5 and 10 mg/l concentrations of the extract for 30 min. The effect on the ability of cercariae to penetrate mice skin, as well as, effect on schistosome worm burden after 8 weeks of infection were measured [150].

To study cytotoxicity and antineoplastic effect in vitro *Solanum nigrum L* extract on U266. U266 cells were cultured together with the extract of *Solanum nigrum* L. Cytotoxicity assay was tested by CCK-8. Cell cycle and apoptosis were determined using flow cytometry (FCM) analysis and cytotoxicity effect on U266 cells. The antineoplastic effect of the drug can partly be ascribed to its apoptotic inducing effect [151]. Model systems have proven enormously useful in elucidating the biochemical function of plant genes. They analyzed transcriptional responses of two native Solanaceous species to the attack of an herbivore whose elicitors are known not to be influenced by diet.

Given that attack from the same herbivore elicits profoundly different responses in two *Solanaceaous* taxa, we conclude that blueprints for commonly regulated responses to plant-herbivore interactions appear unlikely [152]. Nitric oxide (NO) is an antitumour molecule produced in activated macrophages and *Solanum nigrum* is a plant used in oriental medicine to treat tumours. In this study using mouse peritoneal macrophages, these findings suggest that *Solanum nigrum* increases the production of NO by rIFN-gamma-primed macrophages and NF-kappaB plays a critical role in mediating these effects [153].

This study was carried out to investigate apoptotic effects of the glycoprotein (SNL glycoprotein, 150 kDa) isolated from *Solanum nigrum Linne*, which has been used as an anti-pyretic and anti-cancer agent in folk medicine. We found that the *SNL* glycoprotein consists of carbohydrate (69.74%) and protein content (30.26%), which has >50% hydrophobic amino acids containing glycine and proline.

The results of this experiment suggest that the SNL glycoprotein activates caspase-3 in HT-29 cells, independent of ROS [154]. *Solanum nigrum L. (SNL)* has been used in folk medicine for its anti-inflammatory activity. These results indicate that *SNL* glycoprotein causes HT-29 cell death through apoptosis by its ability to modulate anti-apoptotic signals. We suggest that SNL glycoprotein is a natural anti-cancer agent due to its potential to induce apoptosis in HT-29 cells [155].

This paper gave a brief introduction of the effect of *Solanum nigrum* on anti-cancer. The experimental results showed that the total alkaloid isolated from *S.*

nigrum interfered structure and function of tumor cell membrane, disturbed the synthesis of DNA and RNA, while the glycoprotein (150 x 10(3)) isolated from *S. nigrum* might have shown anti-cancer abilities by blocking the anti-apoptotic pathway of NF-kappaB, activating caspase cascades reaction and increasing the production of nitric oxide [156].

The present study was carried out to evaluate the antinociceptive, anti-inflammatory and antipyretic effects of chloroform extract of *Solanum nigrum* leaves using various animal models. The present studies demonstrated that the lipid-soluble extract of *S. nigrum* leaves possessed antinociceptive, anti-inflammatory and anti-pyretic properties and confirmed the traditional claims [157]. This study based on Solanum *nigrum* Linn. (SNL) has been traditionally used as herbal agent in folk medicine for various cancers in Korea. We found that the *SNL* glycoprotein consists of carbohydrate (69.74%) and protein content (30.26%), interestingly, and it may be a potential candidate in field of anticancer drug discovery [158].

Solanum nigrum L. (SN) has been used in traditional folk medicine to treat different cancers. These findings indicate that SNE induced cell death in hepatoma cells via two distinct antineoplastic activities of SNE, the ability to induce apoptosis and autophagocytosis, therefore suggesting that it may provide leverage to treat liver cancer [159]. *Solanum nigrum* Linn. (SNL) has been used in traditional Chinese medicine for centuries because of its diuretic and antipyretic effects. The present study examined the effect of the crude polysaccharides isolated from *Solanum nigrum Linne* (SNL-P) on tumor growth. This resulted in a massive necrosis in tumor tissues and the up-regulation of Bax and down-regulation of Bcl-2 and mutant p53 gene expression, which triggered apoptosis in tumor cells. These findings demonstrated that the SNL-P is a potential antitumor agent [160].

Schistosomes have a complex lifecycle with freshwater intermediate host snails. The snail host represents the weakest point in the lifecycle of parasite.*Biomphalaria arabica* is intermediate host for Schistosoma mansoni in *Saudi Arabia*.The studied enzymes were altered in molluscicide-treated snails compared to control. AST and ALT were slightly affected but LDH was the most significantly altered enzyme.

The role of the biochemical manipulation in affecting host-parasite relationship was discussed [161].

To study the inhibitory effect of *Solanum nigrum* on angiogenesis. The surrounding CAM showed a few angiogenesis formation. However, in the control group, a number of angiogenesis were observed*: S. nigrum* could inhibit the angiogenesis on CAM [162]*. Solanum nigrum L.* (SN) is an herbal plant that has been used as hepatoprotective and anti-inflammatory agent in Chinese medicine. The results of this study suggest that SNE could protect liver against the CCl4-induced oxidative damage in rats, and this hepatoprotective effect might be contributed to its modulation on detoxification enzymes and its antioxidant and free radical scavenger effects [163].

Bone undergoes continuous remodeling through bone formation and resorption, and maintaining the balance for skeletal rigidity. Bone resorption and loss are generally attributed to osteoclasts. Differentiation of osteoclasts is regulated by receptor activator of nuclear factor NF-kB ligand (RANKL), Among 222 methanol extracts, of medicinal plants, 10 samples exhibited ability to induce osteoclast differentiation [164]. To explore the antitumor activity of aqueous extract of *Solanum nigrum* (SNL-AE) and its possible mechanism [165]**.**

Antioxidant studies: Some useful study was based on the antioxidant identification in plant *S.nigrum* & other plant species. Ninety crude extracts, including dichloromethane, methanol and aqueous extracts from 30 medicinal plants used in the *Yemeni* ethnomedicine to treat common infections, and showed effective free radical scavenging activities in the DPPH assay [166]. Some scincetist study based on antioxidant in three *Solanum* genotypes with various polygenic resistance levels to the oomycete pathogen *Phytophthora infestans* (Mont.) De Bary were studied for their antioxidant response to the pathogen culture filtrate [167]**.**

Parasitic & Microbiological studies: Some scincetist study based on Biochemical analyses for pathogenicity achieved with attenuated *cercariae* showed that while serum aspartate and alanine aminotransferases (AST &ALT) were more or less similar, depleted glycogen and elevated lipid peroxides were normalized when

compared to those infected with normal *cercariae* [168]. Sciencetist studied on Molluscicidial activity of leaves of *Acanthus mollis* against *Biomphalaria alexandrina* were evaluated*, S. nigrum* and *I. pseudacorus* extracts (24 hr LC_{50}: 4.01mg/l) showed good result. And an hour respectively. Mortality increased with increasing exposure time and concentration [169]**.**

CONCLUSION: *S. nigrum* is wonderful plants having enormous range of medicinal activity in this article have assanbled almost all information related to different research activity of plant. Although it is mentioned as a component in several popular polyherbal formulations in the form of alcoholic or hydroalcoholic extracts, it is an attractive candidate plant for formulating targeted drugs. This review will help to researchers & scholars to go deep in this area as plant indicate vast range of phytochemical related to origin so it can be suggested the further work can be done on *S. nigrum*. This is collected from different season & agroclimatic zone.

Definitely, it is assumed that research will be able to find out more suitable & specific drug plant having particle activity in specific season. Same type of review paper has been published on *Tribulus terrestris*, a traditionally important wild medicinal herb of waste lands, which became a popular article for further investigations on particular medicinal herbs. All Some scientist these data and concepts are in need to re-research on the present scientific tools. It can really contribute to medical and pharmaceutical practices. There are still many more activities waiting for screening the drug [170].

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