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Review Article

A Review on *Solanum Virginianum* (Solanaceae): Phytochemical and Pharmacological Properties

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Abstract:

Solanum virginianum L. (Syn.: *Solanum xanthocarpum*) Family, Solanaceae; also known as Yellow berried nightshade or Kantkari is one of the members of the dashmula (ten roots) of the Ayurveda. It is a very spiny diffuse herb up to 1.2 m tall, commonly found throughout India, used in medicine in various forms, such as decoction, electuary, ghrita, etc. It is utilized for the curing of fever, bronchial asthma and cough throughout Indian subcontinent since ancient times. Therefore, researchers have tested biological activities of extracts and pure compounds from different parts of this herb. A range of pharmacological effects, such as antiurolithiatic, antihepatotoxic, antioxidative and anti-hyperglycaemic was observed supporting its use in traditional medicine.

Keywords: *Solanum virginianum*, Kantakarika, Solamargine, Mukundara tribals, Dasamulasava. Jigrine

Introduction

Solanum virginianum, a wild eggplant bearing spines, commonly known as “Kantakari” belongs to the family “Solanaceae [1]. Solanaceae family contains 98 genera and more than 3000 species of plants globally. Plants of this family are well known for ethnomedicinal and dietary uses. It is an itchy perennial herb. This herb is also called as ‘Indian night shade’ or ‘yellow berried night shade’ plant. Different parts of this plant are a rich source of varied phytochemicals viz. phenols, saponins, terpenoids, alkaloids, flavonoids, glycosides, and amino acids.

In Ayurvedic system of medicine, this whole plant is used as antimicrobial, antitumor, antipyretic, anti-inflammatory, anti-allergy, anti-fertility, hypoglycaemic, antioxidant, and anti-histamine agents. In addition, the plant is used for treating asthma, skin infection, headache, hair fall, and cough too [2]. It comprises of herbs or shrubs, rarely small trees, and sometimes subscandent or climbing unarmed or prickly. The leaves are entire, lobed, or pinnatifid. Flowers are in lateral or terminal cymes. Fruit is a globose or elongated berry. The prickles are straight, compressed, and yellowish. The leaves are up to 10×6 cm, ovate or elliptic with acute

apex, and pinnatifid half-way down. Petioles have long prickles, and base is very unequal. Flowers are in few-flowered cymes. Calyx is prickly with ovate or lanceolate lobes. Corolla is violet in colour and approximately 2 cm in diameter. Berry is globose, 2 cm in diameter, and yellow or white with green blotches [3].

Regional Names [4]:-

- Sanskrit: Kantakari, Vyaghri, Dhavani, Kshudra, Kantakarika, Kantalika, Nidigadhika
- English: Febrifuge Plant, Yellow night shade.
- Hindi: Katali, Bhatakataiya, Chhotikateri, Ringani.
- Telugu: Nelamulaka, Chinnamulaka, Mulaka, Pinnamulaka,.
- Kannada: Kiragulla, Nelagulla.
- Tamil: Kandangatri, Kandan Katri, Kandangathiri

- Gujarati: Bhorangani
- Bengali: kantakari
- Nepalese: areri..

Distribution:- Occurrence of *Solanum Xanthocarpum* has been found throughout India, in dry conditions as a weed along the roadsides and wastelands, particularly in hills and valley of Manipur (Leipung-Khanga in Manipuri). It naturally spreads by seed in wastelands. However, it is also distributed in Ceylon and Malacca through South East Asia, Malaya, Tropical Australia, and Polynesia [5]. It is generally grown in March to April, fruits from May to June. It grows mainly in hot and dry places, height about 2-3 m, Fruits are white or yellow colored, measured about 1-3 cm, the stem is like zigzag branches are plentiful, bases are somewhat woody.[6]

Taxonomical Classification [7]:-

Kingdom	Plantae
Division	Spermatophyta
Sub- Division	Angiospermae
Class	Dicotyledonae
Sub- Class	Gamopetalae
Series	Bicarpellatae
Order	Polemoniales
Family	Solanaceae
Genus	Solanum
Species	<i>Solanum virginianum</i>

Morphological Description: - [8]

A very prickly diffuse bright green perennial herb, somewhat woody at the base; stem is somewhat zigzag; branches are numerous, the younger ones clothed with dense stellate tomentum; prickles are compressed, straight, yellow, glabrous and shining, often exceeding 1.3 cm. Leaves are usually 5-10 in numbers and 2.5-5.7 cm in length, ovate or elliptic, sinuate or sub pinnatifid, obtuse or sub-acute, stellately hairy on both sides,

sometimes becoming nearly glabrous in age, armed on the midrib and often on the nerves with long yellow sharp prickles, base usually rounded and unequal-sided; petiole 1.3-2.5 cm long, stellately hairy. The berries are green and white strips when young but yellow when mature. They are 1.3-2 cm in diameter, yellow, or white with green veins, surrounded by the enlarged calyx. Seeds are 2.5 mm in diameter and glabrous. Calyx is nearly 1.3 cm long, densely hairy and

prickly; tube short, globules. Lobes are 11 mm long, linear-lanceolate, acute and hairy outside. Filaments are 1.5 mm long,

glabrous; anthers 8 mm long, oblong lanceolate, opening by small pores. Ovary is ovoid, glabrous; style glabrous.



Figure 1: Whole plant of *Solanum virginianum*



Figure 2: Flower of *Solanum virginianum* ,



Figure 3: Leaves of *Solanum virginianum*



Figure 4: Fruit of *Solanum virginianum*

Chemical and Structure Classification:-

The chemical constituents of plant *Solanum xanthocarpum* contain saponins, sterols, alkaloids, flavonoids, and their glycosides,

as well as amino acids, fatty acids, carbohydrate, etc[9].The fruits are reported to contain several steroidal alkaloids like solanacarpine and solamargine. Other constituents like caffeic acid coumarins like

aesculetin and aesculin, steroids carpesterol, diosgenin, campesterol, daucosterol and triterpenes like cycloartanol and cycloartenol were reported from the fruits.[10] Other two types of phenolic substances were obtained from the non-alkaloid part, which then identified as caffeic acid and methyl caffeate. Moreover, the berries are the leading source of diosgenin and solasodine. The fruits are conveyed to contain few steroidal alkaloids as in solanocarpine and solamargine, beta solamargine and solanocarpidine [11]. Dry fruits contain minimum amount of neochronogenic, chronogenic, isochlorogenic and caffeic acids. The petals and stamens yielded

apigenin and quercetin diglycoside, sitosterol respectively. Two particular sterols are found in the unsaponifiable matter of fruits. One is carpesterol (chemically the diosgenin) and beta-sitosterol constituents, however, researchers also found the occurrence of triterpenes (like lupeol). So, fruits extract more alkaloids than other organs in plant species also the production of alkaloids varies under altered organic diluters. Along with alkaloid, determined the incidence of flavonoids and saponins, except for trace amounts of heavy metals (Zn, Cd, Fe, Cu, and Pb) and also reported and measured khaisanine a bioactive glycoalkaloid through HPLC [11].

Table 1

Sr.no.	Phytoactive compounds	Phyto-constituents
1.	Flavones, Phenolics and Coumarins	Apigenin, Scopletin, Esculetin Coumarin, methyl Caffeate and Caffeic acid
2.	Steroids and Triterpenoids	Carpesterol, Campesterol, Lupeol, Cycloartenol, Stigmasterol and Cholesterol
3.	Steroidal alkaloids and Glycoalkaloids	Solasodine, Diosgenin, Tomatidenol and α -Solamargine
4.	Fatty acids	Linoleic acid, Oleic acid and Stearic acid [12]

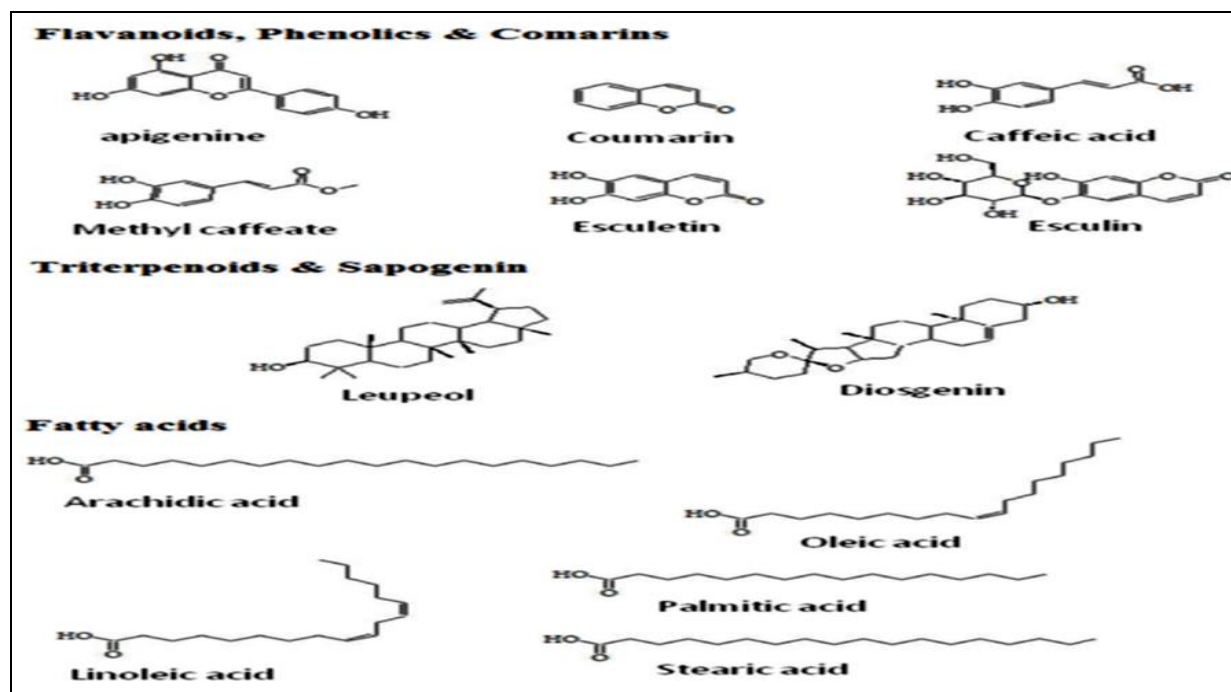


Figure 5: Compounds isolated from *Solanum virginianum* [13]

This review explores the phytopharmacological properties of *Solanum xanthocarpum* and summarizes its wide range of pharmacological applications to understand and integrate potential image issues as multipurpose medicines. Solanocarpidine and a phytosterol known as Carpesterol are also present. The seed oil contains Carpesterol. Diosgenin, lanosterol, sitosterol. Solasonnine, solamargine, and solasodine have been isolated from the plant. The roots and fruits are used for medicinal purposes. The herb is useful both internally as well as externally. The apoptotic effects and the amount of DNA fragmentation increased in a dose-dependent manner after the treatment with the protein [14-17].

Use in Ayurveda:-

The whole plant is used for medicinal purpose including fruits and roots. Root is one of the constituents of Dasamulasava. Jigrine, a polypharmaceutical herbal formulation, used for treatment of liver

ailments contains aqueous extracts of some medicinal plants and *S. xanthocarpum* root is one of them. Mukundara tribals of Rajasthan use paste of the roots in hernia. Decoction of root is given with long pepper and honey, in cough and with rock salt and asafoetida in spasmodic cough. The stem, flowers and fruits are prescribed for relief in burning sensation in the feet accompanied by vesicular eruptions. Leaves are applied locally to treat muscular pain and juice mixed with black pepper is used in rheumatism. The paste applied on painful joints in arthritis, reduces pain and swelling. Juice of berries is reported to be useful in sore throat. A decoction of the fruits of the plant is used by tribal and rural people of Orissa, India for the treatment of diabetes. The fruits are eaten as an anthelmintic and for indigestion. The dried fruits are smoked in the form of cigarettes and smoke held up in the mouth cures dental infections [16-18].

Pharmacological Activity:

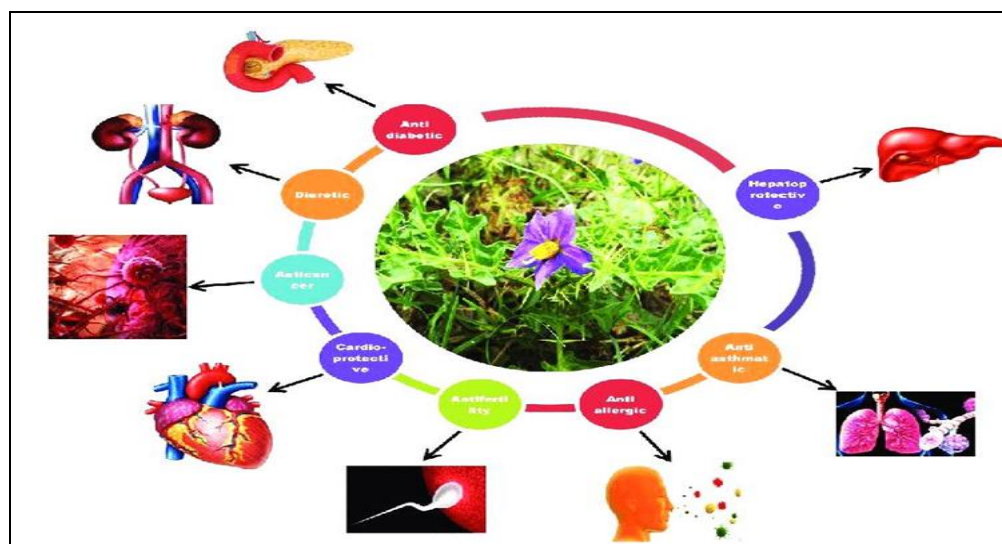


Figure 6: Graphical representation of pharmacological activities [19]

Antiasthmatic / Bronchodilator Activity: Vadnere et al., (2008), studied a noticeable inhibition of histamine-induced contractions produced by ethanol extract of *Solanum*

xanthocarpum flower on isolated goat tracheal chain preparation proved that the *Solanum xanthocarpum* flower has anti-histaminic (H1-receptor antagonist) action.

While screening all three extracts of flowers of *Solanum xanthocarpum*, results indicated that only ethanolic extract of *Solanum xanthocarpum* at a dose of 50 and 100 mg/kg reduced milk induced eosinophilia of statistical worth. *Solanum xanthocarpum* at a dose of (50-100 mg/kg, i.p) exhibited significant mast cell stabilization when compared to standard drug disodium chromoglycate [20]. Bronchial asthma is an inflammatory disorder of the airways characterized by various airway obstruction, airway eosinophilic inflammation and bronchial hyper responsiveness and is a global health problem that results from a complex interplay between genetic and environmental factors.

Nearly 7–10% of the world population suffers from bronchial asthma. Despite the availability of a wide range of drugs, the relief offered by them is mainly symptomatic and short lived. Moreover the side effects of these drugs are on-going to identify effective and safe remedies to treat bronchial asthma. A pilot study on the clinical efficacy of *Solanum xanthocarpum* and *Solanum trilobatum* in bronchial asthma were undertaken to prove the significant use of herbs in treatment of asthma. Effects of *Solanum xanthocarpum* extract studied on some of the parameters like smooth muscle relaxation, and antagonism of asthma mediators such as histamine, eosinophils and protection against mast cell degranulation which seemed to be prominent in pathophysiology of asthma [21]. It was found that *Solanum xanthocarpum* has mild to moderate bronchodilator activity as an Ayurveda drug. This study included Soxhlet process for producing the plant extract, which was used in treating children with respiratory problem and wheezing. Significant results were found using the trial drug comparing with a standard one as 60.71% reduction in wheezing was seen with the trial drug. It was concluded that the

alkaloids and steroids might have had inflammatory action on the bronchial tree that led to bronchospasm [22].

Plant powder can be anti-tussive as its effect on bronchial asthma patient has been explained due to depletion of histamine from lung and its expectorant action because of the inorganic nitrogen presence. It was found that *Solanum xanthocarpum* has mild to moderate bronchodilator activity as an Ayurveda drug. This study included Soxhlet process for producing the plant extract, which was used in treating children with respiratory problem and wheezing. Significant results were found using the trial drug comparing with a standard one as 60.71% reduction in wheezing was seen with the trial drug. It was concluded that the alkaloids and steroids might have had inflammatory action on the bronchial tree that led to bronchospasm [22].

Hypoglycemic or Anti-hyperglycemic Activity: Batabyal *et al.*, (2007) reported a strong reduction of blood glucose levels in ordinary and streptozotocin actuated diabetic rodents.

At 100 and 200 mg/kg, the aqueous concentrate had a significant hypoglycemic effect in both normal and streptozotocin-induced diabetic animals. This action is similar to glibenclamide [23].

The hot aqueous extract of the matured fruits of *Solanum xanthocarpum* is used as a traditional medicine for the treatment of diabetes mellitus. This extract showed significant hypoglycemic effect in both normal and streptozotocin-induced diabetic rats at a dose of 100 and 200 mg/kg. Moreover, the activity showed by the plant extract was equivalent to that of standard oral hypoglycemic agent glibenclamide.

The experimental results were concluded to exhibit potent blood glucose lowering property both in those diabetic rats. It was

also found that the LD50 of the extract was high representing a high margin of safety. The hypoglycemic activity of the crude methanol extracts of the leaves of *Solanum xanthocarpum* at different concentrations (100-200 mg/kg body weight) was tested against alloxan-induced adult diabetic male Wistar rats, and the antidiabetic efficacy was validated through various biochemical parameters. phytochemical analyses of field grown *Solanum xanthocarpum* and in vitro raised *Solanum xanthocarpum* leaves were done and the results revealed that the methanol extracts of both the leaves were efficient antihyperglycemic agents at a concentration of 200 mg/kg body weight [24].

Hepatoprotective activity: In Chandana VR, *et al.* investigation, the Hepatoprotective activity of *Solanum xanthocarpum* extracts is evaluated in rats by inducing hepatotoxicity using CCl₄. The CCl₄ gets converted into CCl₃, which is the main reason for the hepatotoxicity. Elevated levels of the enzyme in rats are seen which are treated using *Solanum xanthocarpum* after inducing hepatotoxicity with CCl₄ indicating the antioxidant activity of *Solanum xanthocarpum*. Jigrine is a polypharmaceutical herbal formulation containing aqueous extracts of 14 medicinal plants including *Solanum xanthocarpum* and used for liver ailments. A K Najmi *et al.* Investigated the DPPH-free radical scavenging activity, hepatoprotective and antioxidant activity of Jigrine against galactosamine induced hepatotoxicity in rats [25].

Cardiovascular effects: Pasnani JS (1988) reported that Abana, a polyherbal formulation containing *Solanum xanthocarpum* causes: (i) A direct sensitization of the atrium through an increase in permeability to Ca²⁺ and (ii) an effect similar to withdrawal of chronic ISO

administration, i.e. down regulation of beta adrenoceptors [25].

Antifilarial effect: Lalit Mohan *et al.* (2006) reported the larvicidal potential of crude extracts of *Solanum xanthocarpum* and suggested its suitability as an ecofriendly, effective larvicide in the management of mosquito populations and in limiting the outbreak of various vector borne epidemics [26].

Mosquito larvicidal effect: Batabyal *et al.*, (2007) reported larvicidal activity of fruit extracts of *Solanum xanthocarpum* against *An. stephensi* and *Cx. Quinquefasciatus* and one culicine species *Ae. aegypti*. The plant has been used in the various fields of pest management but it is not exploited in vector control. Volatile oil obtained from *Solanum xanthocarpum* exhibited repellency against mosquito *Cx. quinquefasciatus* at a very lower concentration than those of the plants studied earlier. The lethal concentrations of fruit extract at LC₅₀ and LC₉₀ levels against *An. culicifacies*, *An. stephensi* and *Ae. aegypti* were determined as 0.112 and 0.258, 0.058 and 0.289 and 0.052 and 0.218% respectively. The root extract is also effective against anopheline and culicine mosquito species, though at higher concentrations in comparison to fruit extract [27].

Wound Healing Activity: Kumar *et al.*, (2010), in their study, used healthy inbred Sprague-Dawley rats to prove the wound healing property of fruit extracts of *Solanum xanthocarpum*. Hot Soxhlet method was used to obtain the coarsely powdered fruits of *Solanum xanthocarpum* extracted with methanol. When treated to the wounds, the methanolic extract of fruits (10% w/w) ointment had produced significant (P40%. Among fungi, noticeable susceptibility was recorded against *Curvularia* sp. (61.29% inhibition) and *Alternaria* sp. (61.14% inhibition) while *Fusarium* sp. was inhibited

to a lesser extent (43.47% inhibition). Wound healing is the repairing processes that follow the skin and other soft tissues injury. When a wound occurs, an inflammatory response initiates and the cells below the dermis start to increase collagen production and later, the epithelial tissue is regenerated. However, previous studies have shown the potential use of leaves, flower, stem, and fruit extracts in the inhibition of certain fungi such as *Aspergillus niger*, *Candida albicans*, etc [28].

Anti-inflammatory Activity: Study conducted by Schrad & Wendl (2018) has found that the anti-inflammatory activity of *Solanum xanthocarpum* is good as compared with standards (Ibuprofen drug). Additionally, this activity is maximum in the forms of ethanolic and chloroform extracts. However, the aqueous extract of dried fruits of *Solanum xanthocarpum* and dried pulp of another plant, *Cassia fistula* Linn was prepared to test the synergistic effect in case of anti-inflammatory property. The mentioned activity of these extracts was investigated using the carrageenan-induced paw edema model in rats individually and in two different combinations and as a result, both the extracts showed maximum anti-inflammatory activity at 500 mg/kg dose. Among the different dose combinations of both the extracts, the 1:1 combination at the 500 mg/kg dose showed maximum percentage inhibition of 75%, which was comparable with the positive control, diclofenac sodium, which showed 81% inhibition. Stigmasterol, carpesterol and diosgenin are responsible for showing the anti-inflammatory effect. Moreover, lupeol in *Solanum xanthocarpum* also acted as multitarget agent with massive anti-inflammatory potential, targeting the key molecular pathways [28].

Chronic inflammation is an unusual reaction that is caused because of chronic diseases such as autoimmune disorders, cancer,

vascular disorders, and arthritis. Natural compounds or extracted are demonstrated as human health rejuvenators with safe and non-toxic properties by various studies. Only a few studies have been investigated for anti-inflammatory effects among the numerous phytochemicals isolated from the herbs. Solanidine, α -solanine, and α -chaconine are having anti-inflammatory effects. The compounds such as carpesterol, diosgenin, and stigmasterol are also found to possess anti-inflammation action. Lupeol which is constituent of *Solanum xanthocarpum* is also having some immense anti-inflammatory potential which can act as a multi-targeting agent. Key molecular pathways can be targeted involving the phosphatidylinositol-3-kinase (P13)/Akt, Fas, Wnt/ β catenin, kappa B (NFkB), cFLIP, and Kras nuclear factors in a variety of cells. Lupeol exhibits no toxicity when administered at its effective therapeutic doses to normal cells and tissues. Hence, it may be employed in the treatment of inflammation as a therapeutic and chemopreventive agent [29].

Anti-bacterial Activity: - Mahmood et al., (2019) reported that anti-bacterial activity can be determined by plethora of methods, for instance, agar well diffusion, disk diffusion and broth diffusion. Amongst these to determine antibacterial activity in plant extracts (in-vitro) agar well diffusion is extensively used. Extract of *Solanum xanthocarpum* has shown anti-bacterial activity against four gram positive bacteria, such as namely, *Staphylococcus aureus* NCIM 5345, *Staphylococcus epidermidis* NCIM 2493, *Bacillus subtilis* NCIM 2063, and *Bacillus cereus* NCIM 2016 and three Gram-negative bacteria, i.e., *Escherichia coli* NCIM 2065, *Pseudomonas aeruginosa* NCIM 2200, and *Salmonella typhimurium* NCIM 2501. Selected bacteria's pure culture was maintained on nutrient agar slants. It was prepared by moving the pure cultures aseptically onto sterile nutrient broth tubes.

Then the tubes were incubated at 37°C. Afterward the broth cultures were used to gage their susceptibility to flower and leaf extract by 'agar well diffusion'. Cork borer was used to punch the wells (diameter 8 mm) and then the wells were labelled and filled with chloramphenicol (reference antibiotic), DMSO and 100 µl of extract (25 mg/ml of DMSO). The plates were further allowed to stand for 30 min and again incubated for 24 h at 37 °C. Finally, the inhibition regions were formed around the wells and measured afterward [30].

Anti-cancer Activity: Mahmood *et al.*, (2019) reported some constituents ie; Lupeol 30, apigenin 31, and solamargine 32, revealed the anti-cancer property of *Solanum xanthocarpum*. Chromatin condensation has shown in solamargine-treated cells, also DNA fragmentation and a DNA histogram (sub-G1 peak) suggested apoptosis in solamargin induced cells. Within 2 h of incubation with persistent concentrations of solamargine, the extreme numbers of dead Hep3B cells were discovered. Since the action of solamargine is irretrievable; prolonged incubation results in no further cell death. Determination of cell phase's susceptibility to solamargine-mediated apoptosis, Hep3B cells were coordinated at distinct cell cycles by colchicine, cyclosporin A, and genistein. Cells in G2/M phases are comparatively predisposed to solamargine-mediated apoptosis. To boot, after solamargine treatment, a parallel upregulation of TNFR (tumour necrosis factor receptor) I and -II on Hep3B cells were identified. Interestingly with either TNFR-I or -II specific antibody, solamargine-mediated toxicity could be neutralized. Thus their autonomous action evidences the contribution in solamargine-mediated apoptosis [30].

Anti-oxidant Activity: Mahmood *et al.*, (2019) reported that the mechanism of the antioxidant property of flavonoids consists

of radical scavenging, metal ion chelation, reducing ability, and inhibition of enzymatic systems liable for free radical cohort. Flavonoid constituents have persuasive water-soluble antioxidant properties which prevent oxidative cell damage. The free radical scavenging activity was measured by DPPH assay as modified by using methanol. Presence of yellow coloured spots against the purple context in TLC-DPPH plate assay specified potential antioxidant action in many subfractions of ethyl acetate, acetone and ethyl acetate extracts along with aqueous sample. The strength of the yellow colour hinge on the extent and the nature of the composites present at that site. Most of the *Solanum xanthocarpum* fruit extracts except benzene and hexane verified appreciable radical scavenging activity at 250 µg/ml concentration enlightening substantial antioxidant possible in the extracts; facilitated by their hydrogen donating ability. Antioxidant activities of the *Solanum xanthocarpum* extracts varied expressively with diverse concentrations [30].

Preventing Post-Menopausal Syndrome: Mahmood *et al.*, (2019) conducted the TLC analysis of *Solanum xanthocarpum* and confirmed the presence of one of the major constituents, steroids. A pilot study showed the estrogen activity of *Solanum xanthocarpum*. In further studies, it has indicated effects on the postmenopausal syndrome. The postmenopausal syndrome is categorized by low estrogen levels leading to sexual dysfunction, depression, vaginal atrophy, and osteoporosis. In this study, β estradiol (1 mg/kg) and *Solanum xanthocarpum* (200 mg/kg) exhibited noticeable improvement in sexual behaviour parameters regarding postmenopausal syndrome [30].

Anti-urolithiatic activity: Chauhan *et al.* (2009) reported the ethnopharmacological use of *Solanum virginianum* for the treatment of urinary track and kidney stones

in Muzaffarnagar, U.P (India). Experimental models treated with ethylene glycol for a period of 28 days resulted, the increase in excretion of Ca²⁺, phosphate, uric acid and a decrease in citrate and magnesium content in urine due to impairment of renal function. Treatment with *Solanum virginianum* extracts improved the renal function by its potential effects like diuretic; anti-oxidant reduced the Ca²⁺ crystal formation. The decreased levels of Ca²⁺ and uric acid was evidenced in plant extract treated group indicates the improvement of renal function and confirms its anti-urolithiatic role.

Similar studies with saponins rich fraction of *Solanum virginianum* fruits resulted that, less number of calcium oxalate crystals and their aggregation in plant extract treated group. Plant extract prevents the formation of calcium oxalate crystals as well as their aggregation. Urinary calculi are the most prevalent disorder of the urinary system. Urinary calculi formed from the oxalates of calcium, phosphates, etc. affect the renal function and decreasing the glomerular filtration rate due to obstruction to the flow of urine. A large numbers of plants are used to cure urinary calculi, since from ancient times. Ancient literature Ayurveda describes the traditional use of *Solanum virginianum* for the treatment of urolithiasis. The anti-urolithiatic efficiency was slightly less compared with the standard drug Cystine. This study confirms the traditional use of *Solanum virginianum* fruits for urolithiasis as effective medicine [31].

Antifertility activity: Dixit and Gupta (1982) reported the anti-spermatogenic property of solasodine, an alkaloid found in *Solanum virginianum* fruits. Administration of solasodine at 20 mg/kg to experimental animal models for the duration of 30 days resulted that testicular lesions and severe impairment of spermatogenesis. Analysis of biochemical like total protein, sialic acid, and glycogen contents of the testis and

epididymis were significantly reduced, whereas the level of testicular cholesterol was increased. Administration of solasodine to castrated dogs, failed to stimulate the epididymal growth. Treatment with solasodine on experimental animals (dogs) affected the male fertility by affecting the androgenesis. Absence of sperms in the cauda epididymis and ductus deferens rendered the male infertile. The findings of these investigations confirm the antifertility role of *Solanum virginianum* fruit and seed extract [31].

Antifertility control the population explosion and also provides a plausible solution to the number of problems what the world confronts. Contraceptive methods, most of the choices, are antifertility agents. Contraceptive drugs available are synthetic/chemical and in many cases found the side effects. Hence, there is a need to replace the chemical drugs by the safe herbal drugs. Many plants have been used as antifertility agents in traditional medicine, but a very few of them evaluated scientifically. Among the contraceptives, availability of male infertility agents is meager. Development of male infertility agents considered to be a potential area of the investigation. Research studies on *Solanum virginianum* reported to possess excellent antifertility activity. Administration of fruit extracts at dose 0.5 mg/kg for duration of 60 days to experimental animal models resulted that arresting the process of spermatogenesis. It was also evident that reduced number of primary and secondary spermatocytes and spermatids correlated with arresting of the spermatogenesis. In testis, leading cells were also significantly decreased, confirms the antispermatogenic nature of *Solanum virginianum* fruit. The *Solanum virginianum* seed extract also reported to possess antifertility efficiency by depleting the oxidative potential of cauda epididymal spermatozoa. Administration of the seed

extract at the dose of 10 mg/kg b.w to experimental animal models for a period of 15 days resulted significant decrease in the level of AST, ALT, glutamate dehydrogenase, Citric acid, and Isocitrate dehydrogenase was observed. Sperm motility was also decreased in the animal model group treated with plant extract. Decreased oxidative potential in the cauda epididymal spermatozoa indicates the antifertility effect of *Solanum virginianum* seeds [31].

Locomotor Activity: - Moha *et al.*, (2005); Mamta *et al.*, (2016), reported the effects of scopolamine which were observed in the rats and related to the action of dopaminergic function. The behavioral effects of spiperone on apomorphine can be reduced by administering scopolamine. In mice exposed to 6-hydroxydopamine, methyl tyrosine suppresses the enhanced scopolamine locomotor activity. When rats are given 6-OHDA together with α -methyltyrosine, the inhibitory activity of spiperone is inhibited. In the brain, unchanged levels of dopamine-related activities of adenylate cyclase and 3Hspiperone confirm scopolamine's postsynaptic connection [32]

Behavioural suppression along with locomotor activity is observed when the mice strains C57BL/6 and ADBA/2 are administered by scopolamine followed by shock treatment. Another study in rats demonstrated the effects of scopolamine on pre and post-synaptic events related to dopaminergic function. Behavioural actions associated with spiperone on apomorphine can be inhibited by treating with scopolamine. α -methyl tyrosine inhibits the increased scopolamine locomotor activity in the animals which are exposed to 6-hydroxydopamine (6-OHDA). The hypothesis of presynaptic dopaminergic fibers associating with scopolamine is supported by the unaffected dopamine- β hydroxylase enzyme. The inhibitory

activity of spiperone is suppressed when the rats are administered with 6-OHDA along with α -methyltyrosine. Postsynaptic association of scopolamine is confirmed by unchanged levels of dopamine associated activity of adenylate cyclase and 3Hspiperone in the brain. Studies on the compounds such desacetylsolaphyllidine from *S. oblongifolium* and solaphyllidine, are performed for understanding their effects on locomotor activity (mice) i.e., reducing the duration of sleep is common for both the alkaloids while solaphyllidine also enhances the locomotor activity [33].

Condensation Effect:-

Studies conducted by Su Y, *et al.* 40 explains that after the incorporation of stigmasterol, cholesterol, sitosterol into dipalmitoyl phosphatidylcholine (DPPC) monolayers, observed the incorporation abilities of all the compounds. It shows that stigmasterol and sitosterol have interacted very less when compared to the phospholipid and cholesterol. All the sterol moieties can source the condensation effect on monolayers of DPPC. Hydrophobic effect or attractive interactions between DPPC and sterol molecules are playing a major role. This can be asserted by negative excess molecular areas at the particularly negative partial molecular area and low surface pressures of three sterols at low surface pressures. Least extraordinary focuses for the overabundance region were altogether situated at around 0.3 mol divisions for three sterols at 30 mN/m, proposing DPPC/sterol (2:1) in requested structures [33].

Suppressing Effect: - Govindan *et al.*, (1999) reported, Cancer that overexpresses HER2. The diosgenin isolated from *Solanum xanthocarpum* suppresses the expression of FAS in breast cells [34]. HER2-overexpressing cancer breast cells contain FAS expression which is suppressed by the diosgenin extracted from *S. xanthocarpum*.

This is because the diosgenin from the extract is responsible for both inhibitions of proliferation and inducing apoptosis in HER2- overexpressing cancer cells. The phosphorylation is also got affected because of it, mTOR and Akt phosphorylation is inhibited whereas the JNK phosphorylation is enhanced. The study conducted using the pharmacological inhibitors explains that JNK, mTOR, and Akt modulated phosphorylation is important for FAS suppression induced by diosgenin. The cytotoxicity in HER2 overexpressing which is induced by paclitaxel can be enhanced by diosgenin. Hence diosgenin can act as potential chemoprotective agent in the treatment of cancers which overexpress HER2 [35].

Miscellaneous Activities:-

In the year of 1982, Dixit VP has reported *Solanum xanthocarpum* has an anti-androgenic activity of solasodine, which is a plant alkaloid. An anti-fertility effect of solasodine is reported in the male rats and dogs during farther studies. The methanolic extract of *Solanum xanthocarpum* fruits contains carpesterol and four steroidal glycosides which when isolated, shows radial growth inhibition on *Aspergillus niger* and *Trichoderma viride*. Antifungal activity is exhibited against *A. brassicae* by the *Solanum xanthocarpum* dried fruit tissues methanolic extract. The abdominal constrictions in mice induced by acetic acid can be suppressed dose-dependently by giving the methanolic extracts of *Solanum xanthocarpum* aerial parts [35].

Summary and Conclusion:-

Nowadays herbal medicines have demand in the market because of their cost-effectiveness friendly peculiarity. Hence a lot of attention has been giving to herbal formulations. Number of pharmacological activities has been reported from the studies on *Solanum xanthocarpum* because of the

presence of medicinally crucial components like campeferol, diosgenin, campesterol, solasonine, and numerous useful alkaloids. Carpesterol, a novel Phytosterol obtained from different plants of the family Solanaceae possesses several pharmacological activities not previously found within the group have been discovered. The most notable of these new properties are anti-inflammatory, antihyperlipidemic activity, digitalis-like activity, coronary dilatory activity, and central nervous system activity. At the same time, some new biological activities are also being mentioned i.e. with androgenic, estrogenic, progestational and anti-tumour activity. In recent advantages related to anticancer drug research, it is a fact that cox-1/cox2 has a significant role in apoptosis. Cox-2 inhibition of leukotrienes on human erythroleukemia (HEL) and human acute monocytic leukemia (Mono Mac 6) cell lines indicated that the compound having cox-2 inhibition could be co-related in anti-cancer activity. By its structure (basic steroidal nucleus) possesses all the activities mentioned under steroids. The over-attachment group further contributes to anti-fertility; cancer of the human reproductive system and HIV-mediated cancers like other Phytosterol, e.g., β -sitosterol is also Phytosterol. It's also rivals the new research on how the different phytochemicals of *S. xanthocarpum* are active in the biological system. There is also a wide space for researchers to evaluate the more incredible potential of this miraculous plant.

References:-

1. Javaid Usman¹, Javaid Sana^{1,2}, Ashraf Waseem¹, Md. Rasool Fawad³, Noman M. Omar⁴, Alqahtani S. Ali⁴, Majeed Abdul³, Shakeel Waleed¹, Albekairi H. Thamer⁵, Alqahtani Faleh⁵, and Imran Imran¹ "Chemical Profiling and Dose-Dependent Assessment of Fear Reducing and

- Memory-Enhancing Effects of Solanum virginianum in Rat”, Dose-Response: An International Journal, Pg No. – 1-18, Year-2021
2. K. Saraswathia 1, R. Bharkavi b, Ameer Khusro c 1,C. Sivarajd, P. Arumugam e, Saad Alghamdif, Dabool S.Anas g, Almeahmadi Mazen h, Bannunah M.Azzah i, Muhammad Sahibzad K.Umar “Assessment on in vitro medicinal properties and chemical composition analysis of Solanum virginianum dried fruits” Arabian Journal of Chemistry (volume14, issue12) Pg No .- 1-13, Year-2021
 3. TR Prashith K.1, HL Raghavendra2*, MR Rajesh1, HC Avinash1, GN Ankith1, K N Karthik1 “Antimicrobial, Insecticidal, and Antiradical Activity of Solanum Virginianum L. (Solanaceae)” Asian Journal of Pharmaceutical and Clinical Research (Volume10, Issue11) Pg No. - 164-167, Year-2017
 4. Fathima T, Suresh Joghee* and Akaash M *Corresponding author: Suresh Joghee, “Solanum Xanthocarpum: A Review” International Journal of Pharmacognosy and Chinese Medicine (Volume 3, Issue 3) Pg No. - 1-7, Year-2019 https://www.researchgate.net/profile/Joghee-Suresh/publication/346112818_Andrographis_Paniculata_A_Review/links/5feaaac745851553a00192ce/Andrographis-Paniculata-A-Review.pdf
 5. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSRL), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 6. Fathima T, Suresh Joghee* and Akaash M *Corresponding author: Suresh Joghee, “Solanum Xanthocarpum: A Review” International Journal of Pharmacognosy and Chinese Medicine (Volume 3, Issue 3) Pg No. - 1-7, Year-2019. https://www.researchgate.net/profile/Joghee-Suresh/publication/346112818_Andrographis_Paniculata_A_Review/links/5feaaac745851553a00192ce/Andrographis-Paniculata-A-Review.pdf
 7. Madhavi H Rane, Neha K Sahu, Saininand S Ajgoankar, Nikhil C Teli, and Deepa R Verma* “A Holistic Approach on Review of Solanum virginianum. L.” Research and Reviews: Journal Of Pharmacy And Pharmaceutical Sciences (Volume-3, Issue-3,) Pg No.-401 303, Year-2014
 8. Sachin Parmar*, Amit Gangwal, Navin Sheth “Solanum xanthocarpum (Yellow Berried Night Shade): A review” India Scholars Research Library Der Pharmacia Lettre, (Volume-2, Issue-4) Pg No. - 373-383, Year-2010
 9. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science And Review (IJSRL), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 10. Sachin Parmar*, Amit Gangwal, Navin Sheth “Solanum xanthocarpum (Yellow Berried Night Shade): A review” India Scholars Research Library Der Pharmacia Lettre, (Volume-2, Issue-4) Pg No. - 373-383, Year-2010

11. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., "Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review" International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
12. Poojari C. Anukthi and Bhalerao A. Satish* "Phytochemical and Pharmacological Profile of Solanum Xanthocarpum Schrad and Wendel: A Review" World Journal of Pharmaceutical Research (Volume 7, Issue 11), Pg No. - 482-491, Year-2018
13. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., "Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review" International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
14. Tekuri Kumar Siva1, Pasupuleti Kumar Sivarama2, Konidalal Kumar Kranthi, Amuru Rani Shobha1, Bassaiahgari Purusotham1, Pabbaraju Neerajal* "Phytochemical and Pharmacological activities of Solanum surattense Burm. f.–A review" Journal of Applied Pharmaceutical Science (Vol. 9, Issue 3), Pg No.-126-136, Year-2019(<http://www.japsonline.com>)
15. Poojari C. Anukthi and Bhalerao A. Satish* "Phytochemical and Pharmacological Profile of Solanum Xanthocarpum Schrad and Wendel: A Review" World Journal of Pharmaceutical Research (Volume 7, Issue 11), Pg No. - 482-491, Year-2018
16. Singh Kumar Ranjan * 1, Garg Ajay 2 and Shrimali Khushboo 3 Singh et al., "A Brief Review on Solanum Xanthocarpum Along With the Evaluation of Anticancer Potential in Carpesterol" International Journal of Pharmacognosy, Vol. 9, Issue 4, Pg No.-67-75, Year-2022
17. Srivastava V.1, Navabharath M. 2, Gupta S. 2, Singh S. V. 2,* and Ahmad S. 1,* "Exploration of Solanum xanthocarpum Schrad. & Wendl against Mycobacterium avium Subspecies paratuberculosis and Assessment of Its Immunomodulatory and Anti-Inflammatory Potential" Pharmaceuticals (MDPI), Volume 15, Issue 11, Pg No. - 1-15, Year-2022
18. Konar Abhishek1*, Chatterjee Reshmi2 "Solanum Xanthocarpum-A Critical Approach to the Lesser Known Aspects of the Herb" International Journal of Scientific Research and Biological Sciences (Vol.9, Issue.5), Pg No.-52-56, Year- 2022 (www.isroset.org)
19. Pareek Rashmi "A Review: Medicinal Potential of Solanum xanthocarpum" International Research Journal of Management Science & Technology, (Volume 8, Issue 3), Page: - 225, Year-2017 (<http://www.irjmst.com>)
20. Tekuri Kumar Siva1, Pasupuleti Kumar Sivarama2, Konidalal Kumar Kranthi, Amuru Rani Shobha1, Bassaiahgari Purusotham1, Pabbaraju Neerajal* "Phytochemical and Pharmacological activities of Solanum surattense Burm. f.–A review" Journal of Applied Pharmaceutical Science (Vol. 9, Issue 3), Pg No.-126-136, Year-2019(<http://www.japsonline.com>)
21. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., "Exploring the Medicinal

- Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
22. Parmar Sachin*, Gangwal Amit, Sheth Navin “Solanum xanthocarpum (Yellow Berried Night Shade): A review” India Scholars Research Library Der Pharmacia Lettre (Volume-2, Issue-4), Pg No. - 373-383, Year-2010
 23. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 24. Laware G. Sandip*, Shirole L. Nitin, “A systematic review on Solanum xanthocarpum L. (Solanaceae) plant and its potential pharmacological activities” International Research Journal of Plant Science (Vol. 13, Issue-2), Pg No.-01-9, Year-2022
 25. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 26. Fathima T, Joghee Suresh* and Akaash M *Corresponding author: Joghee Suresh “Solanum Xanthocarpum: A Review” International Journal of Pharmacognosy and Chinese Medicine Volume 3 Issue 3, Year- 2019 https://www.researchgate.net/profile/Joghee-Suresh/publication/346112818_Andrographis_Paniculata_A_Review/links/5feaac745851553a00192ce/Andrographis-Paniculata-A-Review.pdf
 27. Subharani K. “Chemical Constituents and Medicinal Properties of Solanum Xanthocarpum: A Review” International Journal of Science and Research (IJSR) Volume 5 Issue 10, Pg No. - 824-826, Year- 2016 (www.ijsr.net)
 28. Laware G. Sandip*, Shirole L. Nitin, “A systematic review on Solanum xanthocarpum L. (Solanaceae) plant and its potential pharmacological activities” International Research Journal of Plant Science (Vol. 13, Issue-2), Pg No.-01-9, Year-2022
 29. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 30. Subharani K. “Chemical Constituents and Medicinal Properties of Solanum Xanthocarpum: A Review” International Journal of Science and Research (IJSR) Volume 5 Issue 10, Pg No. - 824-826, Year- 2016 (www.ijsr.net)
 31. Mahmood Anika 1, Jurashe Partha S. 1 and Dash Pritesh R. * 2 Mahmood et al., “Exploring the Medicinal Importance of Solanum Xanthocarpum: A Review” International Journal of Life Science and Review (IJSLR), (Vol. 5, Issue 7), Pg No. - 104-111, Year- 2019 [PDF] ijlsr.com
 32. Tekuri Kumar Siva1, Pasupuleti Kumar Sivarama2, Konidalal Kumar Kranthi, Amuru Rani

- Shobha1,Bassaiahgari Purusotham1, Pabbaraju Neeraja1* “Phytochemical and Pharmacological activities of Solanum surattense Burm. f.–A review” Journal of Applied Pharmaceutical Science (Vol. 9, Issue 3), Pg No.-126-136, Year-2019 (<http://www.japsonline.com>)
- 33.** Laware G. Sandip*,Shirole L. Nitin, “A systematic review on Solanum xanthocarpum L. (Solanaceae) plant and its potential pharmacological activities” International Research Journal of Plant Science (Vol. 13, Issue-2), Pg No.-01-9, Year-2022
- 34.** Fathima T, Joghee Suresh* and Akaash M *Corresponding author: Joghee Suresh “Solanum Xanthocarpum: A Review” International Journal of Pharmacognosy and Chinese Medicine Volume 3 Issue 3, Year- 2019 https://www.researchgate.net/profile/JogheeSuresh/publication/346112818_Andrographis_Paniculata_A_Review/li nks/5feaaac745851553a00192ce/Andr ographis-Paniculata-A-Review.pdf
- 35.** Laware G. Sandip*, Shirole L. Nitin, “A systematic review on Solanum xanthocarpum L. (Solanaceae) plant and its potential pharmacological activities” International Research Journal of Plant Science (Vol. 13, Issue-2), Pg No.-01-9, Year-2022
- 36.** Fathima T, Joghee Suresh* and Akaash M *Corresponding author: Joghee Suresh “Solanum Xanthocarpum: A Review” International Journal of Pharmacognosy and Chinese Medicine Volume 3 Issue 3, Year- 2019 [https://www.researchgate.net/profile/JogheeSuresh/publication/346112818_](https://www.researchgate.net/profile/JogheeSuresh/publication/346112818_Andrographis_Paniculata_A_Review/li nks/5feaaac745851553a00192ce/Andr ographis-Paniculata-A_Review/li nks/5feaaac745851553a00192ce/Andr ographis-Paniculata-A_Review.pdf)Andrographis_Paniculata_A_Review/li nks/5feaaac745851553a00192ce/Andr ographis-Paniculata-A_Review. pdfugust 2018, 226-230.