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REVIEW ARTICLE

A REVIEW ON PHYTO PHARMACOLOGICAL ASPECTS OF *PELTOPHORUM PTEROCARPUM* (DC) BAKER EX. K HEYNE.

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Abstract

Peltophorumpterocarpum (family-Fabaceae) is a beautiful ornamental tree used in therapies since from the traditional medicine. The various parts of the plant (seeds, flowers, leaves, bark and root) have been scientifically proved to be antidiabetic, antimicrobial, cardiotonic, hepatoprotective, antioxidant, free radical scavenging, anticancerous, buteryl and acetyl choline esterase inhibitory, cytotoxic and estrogenic. The aim of this review is to document the entire phytochemical and pharmacological information of *P. pterocarpum* and it covers the literature up-to 2015.

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Introduction:-

Today, the prevalence of life-threatening complex diseases has increased all over the world. The inventions of new effective therapeutic agents are essential to eliminate such complex diseases. As now, available synthetic drugs are less effective, with many side effects, allergic and also result in organ damage. Thus, an alternate therapy from nature is needed. Herbal medicines are such an excellent alternate which are cheapest, safer, abundant, easily available and with no side effects. In India, over 3600 plant species have been considered to be useful in the treatment of several diseases. Numerous studies have been implicated worldwide in the identification and isolation of new therapeutic compounds from various herbal plants to treat the existing and newly arousing diseases.*Peltophorumpterocarpum*is one among that, having immense medicinal properties, but its utility is reducing these days. Thus, it was decided to document the scientifically proven literature of *P. pterocarpum.* Hence, it will help the upcoming researchers to recognize the usage of different parts of *P. pterocarpum* and include it for their novel inventions.

Botanical description:-

Peltophorumpterocarpum is commonly known as golden flamboyant, yellow flame tree, yellow poinciana, yellow flamboyant, copperpod, kondachinta (in Telugu), radhachura (in Bangala), perunkonrai (in Tamil). *P. pterocarpum* is inhabitant to the Indo-Malaysian region, and also seen in the regions of Andaman Islands and Sri Lank. In India, the common flowering period is from March to May, though the intermittent flowering may occur throughout the year.*P. pterocarpum* is a quickly growing deciduous tree typically attaining a height of about 15 (-24) m, it may reach up to 50 mand a diameter of about 50 (-100) cm.[1] *P. pterocarpum* has a broad scattering crown. It has a

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brown-tomentose inflorescence.[2]The flowers are orange-yellow in color, all about 2.5 cm in diameter. Fruits are with 1-4 seeded pods, flattened, thin and winged about 5-10 cm elongated, which are deep red while ripen and then turns black. Leaves are hefty and much separated, with 30-60 cm elongated; having 8-10 pairs of pinnate each showing10-20 pairs of quadrilateral leaflets of about 0.8-2.5 cm in length.[3] The barks are grey, smooth and with a deep root system.[4] It is potentially grown for reforestation, in agro forestry.[5] Woodis used for construction, cabinet making and as a fuel.[3] Bark is the important component of the black 'soga' dye for batik work, for tanning leather and to ferment palm wine. In ayurvedic medicines, it is used as an astringent for curing intestinal complaints after pain at child births, bruises, sprains, swellings, sores, eye troubles and muscular pains.[1,3]

Figure: 1*Peltophorumpterocarpum*

Phytochemical Studies:-

Phytochemicals are natural and non-nutritive bioactive compounds obtained from the plants. The phytochemicals may be of any types based on its biosynthetic origin. These Bioactive compounds has the ability to interact with more than one component(s) of the living tissues by providing a broad range of therapeutic effects such as antioxidant, antimicrobial, antifungal, anticancerous, anti-inflammatory, neuroprotective and radioprotective.[6] Sukumaran*et al*in (2011) revealed the presence of phenolic compounds, flavanoids, saponins, steroids, tannins, xanthoproteins, carboxylic acids, coumarins and carbohydratcs in the methanol extract of *P. pterocarpum* flowers.[7] Many monoterpenes and sesquiterpenes present in the ethyl acetate stem extract of *P. pterocarpum* by GC MS (Gas Chromatography Mass Spectrometry). The major compound identified was valeranone, β-sitosterol, isosativene, hexadecanoic acid and octadecanoic acid which are reported to possess various biological activities.[8]

A variety of glycosides by using HPTLC (High Performance Thin Layer Chromatgraphy) and also flavanoids, glycosides, sugars, alkaloids, catechin, phenols, tannins and saponins were identified in the methanolic flower extract of *P. pterocarpum*. Glycosides are reported to possess various therapeutic properties as cardiac drugs, laxatives, analgesics, renal disinfectants, anti inflammatory, expectorant, anti-rheumatics and anti-spasmodic.[9] Dilipgorai(2013) have founded the four bioactive phytoconstituents in the methonolic extract of the flowers of *P. pterocarpum*. They are characterized as hentriacontanol, bergenin, Kaemferol and quercetin using various spectroscopic data and chemical studies.[10] Joseph Joseline*etal* (2014) explored the phytochemical constituents in the aqueous, petroleumether, chloroform, ethanol and acetone extracts of petals of *P. pterocarpum* and founded the phenolic compounds, phytosterols, coumarins in all the extracts. Flavanoids in aqueous, ethanol and acetone extracts. Terpenoids in all the extracts of *P. pterocarpum*except the ethanolic extract. Steroids in petroleum ether and chloroform extracts. Quinones in petroleum ether extract. Proteins were detected in aqueous, petroleum ether, chloroform and ethanol extracts and carbohydrates in aqueous and chloroform extracts.[11] The presence of diverse secondary metabolites like saponins, terpenoids, steroids, tannins, phenols, alkaloids and coumarins in the leaf extract of *P. pterocarpum* were confirmed by Amala*etal*in (2015).[12]PoojaMoteriya*etal* (2015)performed the preliminary qualitative phytochemical screening and found to possess the phytoconstituents like alkaloids, flavanoids, triterpenes and tannins in different amounts in the *P. pterocarpum* flower extracts.[13]

Pharmacological Studies:-

Antimicrobial activity:-

The bacterial cell aggregation effects of ethanolic extracts of 8 Thai medicinal plant had done by using salt aggregation test, against enterohemorrhagic*Escherichia coli* strains (E-*Coli* 0157:H7). Among the 8 plants only 4

showed high bacteriostatic and bactericidal activities. The ethanolic extracts of *Quercusinfectoria, P. pterocarpum,Punicagranatum* were found to be most effective against the strains of E-coli 0157:H7.[14] The antibacterial and antifungal activities of *P. pterocarpum*leaf extracts against *Staphylococusaureus ,E. coli* and *Candida albicans.* In four extractions (hexane, dichloromethane, ethylacetate and ethanol) of *P. pterocarpum* tested the ethanol extract showed greater antimicrobial inhibitory activity at 0.18 mg/10mL plate of medium especially against *E. coli* and *S. aureus*.[15]

Sathish*etal* in (2007) tested various extracts of 52 plants for their antifungal potential against eight species of *Aspergillus* such as *A. candidus, A. columnaris, A. flavipes, A. flavus, A. fumigatus, A. niger, A. ocharaceus* and *A. tamari*. Among 52 plants, the aqueous extract of *Acacia nilotica, Mimusopselengi, P. pterocarpum*,etc., have recorded the significant antifungal activity.[16] The inhibitory and killing activities of crude aqueous and methanolic extracts of 13 kinds of Thai herbs including *P. pterocarpum* against 20 strains of multiple antibiotic resistant *Helicobacterpylori*, one major causes of gastric cancer were determined. Most strains of H. *pylori* were proved to be inhibited by *P. pterocarpum, Piper betle, P. granatum*and *Q. infectoria*.[17]

The antibacterial activity in acetone and hexane extracts of *P. pterocarpum, Bauhinia purpurea* and *Colvillearacemosa* against eight chosen isolates of *S. aureus, S. epidermidis, Pseudomonas aeuriginosa, Klebsiellapneumoniae, Bacillus subtilis, S. marcescens, E. Coli* and *Pseudomonas fluorescens* were analyzed. Among 3 plants, the *P. pterocarpum* (hexane extract) exhibited the maximum inhibition against *K. pneumonia*, at a zone of inhibition (IZ: 25 mm) in 225 µg/mL concentration.[18] Lam in (2010) first reported an antifungal amidases from *P. pterocarpum*seeds. The isolated protein is known as peltopterin, found to impede the mycelial growth in *Rhizotoniasolani* with an IC_{50} of 0.65 microm. It also potently inhibited the HIV-1 reverse transcriptases with an $IC_{50}$of 27 nm.[19]

The *in-vitro* antimicrobial activities in the methanolic extracts of selected Indian medicinal plants on the various test microorganisms such as, *Alternariaalternate, Aspergillusflavus, Fusariumoxysporum, Xanthomonascompestries*werestudied and found the methanolic extract of *P. pterocarpum*and *Adenocalymaalliaceum* having the strong antimicrobial activity.[20] Karunai Raj *etal* (2012) isolated bergenin from the methanolic extract of *P. pterocarpum* flowers and tested against bacteria and fungi. Bergenin showed the antifungal activity against *Trichophytonmentagrophytes, Epidermophytonfloccosum, Trichophytonrubrum, Aspergillusniger, Botrytis cinera* and no antibacterial activity was seen.[21]

The antimicrobial activity in the extracts such as petroleum ether, dichloromethane, ethyl acetate and methanol fractions of *P. pterocarpum* stem against *B. subtilis,P. aeruginosa* and *S. aureus*were demonstrated. The maximum activity occur in the ethyl acetate extraction against *P. aeruginosa* and *S. aureus* (1Z:17.33±0.33, 17.00 ± 0.00), with MIC (Minimal Inhibitory Concentration) of 31.25 and 125 µg/mL, respectively and the antifungal activity in methanol fraction of *P. pterocarpum* against *T. rubrum* (1Z:17.00 ± 1.00 mm, MIC: 500 µg/mL).[8]

Antidiabetic activity:-

Saiful Islam *etal*in (2011) identified that the methanol and ethyl acetate (1:9) extract of *P. pterocarpum* (flowers, 200 mg/kg body weight) on glucose and alloxan induced diabetic mouse models have reduced the blood glucose by 60.40% and 65.48% by metformin.[22] Saiful Islam *etal* again found the methanol and ethyl acetate (1:9) root extract of *P. pterocarpum* (200 and 300 mg/kg b.w) on alloxan and glucose induced mouse models have significantly reduced the blood glucose level in the diabetic models. The brine shrimp lethality bioassay was also done and showed the LC_{50} value 28.25 µg/ml at 300 mg/kg of the extract. Thus the plant possess antidiabetic activity with low cytoxicity.[23] ThamilvaaniManaharan*etal* (2011) evaluated the α-glucosidase, α-amylase, aldose reductase inhibition, phenolic content and glycation end products formation inhibition activities in the leaf and bark extracts of *P. pterocarpum* and proved to have more significant antiglycemic activity, compared to that of acarbose (commercial carbohydrate inhibitor) and also identified that the active compound may be quercetin – 3-0-β-d galactopyranoside. [24] The antihyperglycemic, α-amylase and α-glucosidase inhibition activities and total phenolic content in 14 plant extracts (ethanolic and aqueous) including *P. pterocarpum*were performedand found to possess potent antihyperglycemic activity.[25]

Antioxidant, free radical scavenging and anticancerous activities:-

Eun-Michoi*etal*in (2005) screened *P. pterocarpum* for their inhibitory effects on the nitric oxidie (NO) release in lipopoly saccharide (LPS) – stimulated RAW264.7 macrophages and for the antioxidant activity and found 50

methanolic extracts inhibited (>50%) LPS – induced NO release from RAW264.7 cells at 50 µg/ml and the free radical scavenging effect found to be more in 6 methanolic extract at 0.5 µg/ml concentration.[26] Different parts of *P. pterocarpum* founded to acquire strong antioxidant activity with total phenolic content in the ethanolic extract and also founded that the extract is not cytotoxic to 3T3 and 4T1 cells at 100 µg/ml concentration.[27]

Jain *etal* (2012) demonstrated the antioxidant activity in the ethyl acetate and methanol extractions of *P. pterocarpum*stem by DPPH (Diphenylpicrylhydrazyl) assay and FRAP (Fluorescence Recovery after Photo bleaching) method and found the extract very active at 6 µg/mL with IC_{50} value of 96.70 ± 0.22 at 80 µg/mL concentration and methanolic extracts about 7 µg/mL with IC_{50} value of 94.25 ± 0.59. FRAP method showed 1310.00 ± 0.00 AAE/mg dw (Ascorbic Acid Equivalent) antioxidant potential in ethyl acetate and 1240.00 ± 5.79 AAE/mg dw in methanolic extracts.[8] The anti-cancer activities of Thai medicinal plant recipes from the database "MANSOROI II" on HeLa cancer cell line were tested by JiradejMansoroi*etal*. in (2012). They tested 40 (aqueous) extracts of plants and found the recipe of NO39 (*Nymphoidesindica, P. pterocarpum* and *Polyalthiadebilis*) having higher anti-proliferative effect.[28] Jie Zhang *etal* in (2013) derived bergenin and gallic acid from the ethyl acetate soluble fraction of the wood of *P. pterocarpum* to demonstrate the inhibitory effect against skin tumor promotion and Epstein-Barr virus early antigen (EBV-EA) activation. Both the compounds exhibited melanogensis-inhibitory activities in α-MSH (melanocyte stimulating hormone) stimulated B16 melanoma cells and the gallic acid showed strong DPPH radical – scavenging activity.[29]

The methanolic extract of *P. pterocarpum*pods produced significant free radical scavenging activity (73.29 ± 0.81 %), nitric acid scavenging activity (84.25 ±1.18 %), superoxide anion scavenging activity (89.03 ± 1.07 %) and metal chelating activit (64.12 ± 0.11 %) and the anti-haemolytic activity (79.09 ± 0.75 %) in 500 µg/ml concentration. Thus the plant proved to contain good antioxidant effect.[30] Carotenoids were extracted from the leaves and flowers of *P. pterocarpum* to reveal its antioxidant activity and found the carotenoid pigments of leaves and flowers having the highest antioxidant activity and the maximum activity in the dose of 100 µg/ml concentrations of the extract and 150 µg/ml for DPPH antioxidant assay by Jean Tony Amalya*etal*.[31] The *in-vitro* free radical scavenging activity in the hexane, ethyl acetate and acetone extracts of *Neriumindicum, Rosaspps., P. pterocarpum* flowers were evaluated and the maximum FRAP activity were observed in acetone extracts and ABTS (2, 2-Azobis-(3-ethylbenzothiozoline-6-sulphonic acid) activity more in ethyl acetate extract of *P. pterocarpum* flowers.[32]

Cytotoxic activity:-

The apoptotic properties of methanolic extracts of *Cassia alata, Cassia auriculata, P. pterocarpum* leaves were determined in the treatment of MCF-7 (Michigan Cancer Foundation-7) Breast Cancer cell line. MTT (3-[4,5-dimethylthiazol2-yl]-2,5-diphenyltetrazolium) assay was used to determine the cytotoxic effects and founded to be more in *P. pterocarpum*at 3 mg/ml. Jaabir*etal*. (2009).[33] Saiful Islam et al in (2011) evaluated the cytotoxic activities in methanol:ethylacetate extract (1:9) of the *P. pterocarpum* flowers against Ehrlich Ascites Carcinoma cells bearing mice. The flower extract showed 30 % cell growth inhibition at a dose of 50 mg/kg.[34] Karunai Raj *etal*isolated the alkaloid, cinnamic acid derived bisamide (E,E)- terrestribisamide for the first time in the extract (methanolic) of *P. pterocarpum* flowers. The compound revealed the prominent *in-vitro* cytotoxic activity against COLO320 (colorectal adenocarcinoma cell line). It showed 83.22 % activity in 200 µg/ml with IC_{50} value of 50 µg/mL.[35]

Analgesic activity:-

The *in-vivo* analgesic activity in the methanol and ethyl acetate (1:9) extracts of *P. pterocarpum* flowers were investigated. The analgesic activity was evaluated by acetic-acid (0.7 %) induced writhing mice models and is observed for the contraction of the body (writhing) in a 5 minute interval. The extract (at 200 mg/kg and 400 mg/kg) treated acetic-acid induced models showed decreased abdominal muscle contraction caused by acetic-acid.[34]

Cardioprotcetive activity:-

The cardiotonic activity of *P. pterocarpum*flowers(ethanolic extract) at 50 mg/kg b.wi.p (intra peritoneal) was found to be more effective in the isolated frogs heart assembly. This was characterized by positive inotropic and slightly negative chronotropic actions. The cardiac enzymes also resulted in the decreased activity of Na^+ K^+ ATP_{ase} and Mg^{2+} ATP_{ase} and an increase in Ca^{2+} $ATP_{ase.}$ It may due to the steroidal glycosides present in the *P. pterocarpum* flower extracts.[36]

Hepatoprotective activity:-
The hepatoprotective effect in the leaves of *P. pterocarpum*(70% ethanolic extract) were evaluated against the paracetamol (2 gm/kg, per orally) induced albino wistar rats. The extracts (100 mg/kg and 200 mg/kg) considerably reduced the high levels of the hepatic markers such as SGPT (Serum Glutamic-Pyruvic Transaminase), SGOT (Serum Glutamic Oxalo acetic Transaminase), ALP (Alkaline phosphatase), bilirubin, triglycerides, total cholesterol, depleted tissue GSH (Glutathione) and lipid peroxidation.[37]

Buteryl and Acetylcholine esterase inhibitory activity:-
Taiwo*etal* in (2010) evaluated the acetylcholine and buteyrlcholinesteraseinbhibitoryeffect of 22 Nigerian medicinal plants including *P. pterocarpum*were determined. The *P. pterocarpum*root-bark showed (49.5%) and stem-bark (68.85%) of acetylcholine esterase inhibition in 42.5 µg/mL concentration.[38] The acetyl cholinesterase activity of *P. pterocarpum* (methanolic extract) bark in D-galactose and scopolamine induced rats were evaluated. The D-galactose induced oxidative stress and the scopolamine induced memory impairment were prevented by the extract. The methanol extract (500 mg/kg) in treated groups improved the memory in plus maze 6 Y maze tests, also reduced the acetyl cholinesterase activity, increased the activity of brain antioxidant enzymes (super oxide dismutase, catalase and GSH) and also decreased lipid peroxidation.[39]

ElufioyeTaiwo*etal* (2013) determined the cholinesterase inhibitory activity in the *P. pterocarpum* (leaf, root-bark and stem-bark) were assessed and found the methanolic extract of stem-bark having maximum activity (of 68.85 ±3.53%) towards acetylcholine esterase (42.5 µg/ml), followed by root-bark which inhibited acetylcholine esterase and buterylcholine esterase at 48.46 ± 4.47 and 51.77 ± 2.020, respectively. Thus the plant is proved to be neuroprotective and can also be used in the treatment of brain dysfunctions such as Alzheimer's disease.[40]

Estrogenic activity:-
Polaseke*t al* (2013) isolated the new compound peltogynoidophioglonin and 2-phenoxychromones with its 3'-o-β-o-glucoside derivative were isolated for the first time in the *P. pterocarpum* leaf (dichloromethane extract) to evaluate their estrogenic activity. The structures were identified by spectroscopic and chemical methods. The first compound peltogynoidophioglonin was found to have the effective estrogenic activity in the different models of cell systems.[41]

Conclusion:-
The present review covers the up-to-date information of the phytochemical and pharmacological studies of *P. pterocarpum* (flowers, pods, leaves, stem, bark and wood). Further need is to isolate and identify new compounds from the various parts of the plant for future studies. Also the above reviewed activities substantiate that the plant *P. pterocarpum*can be included in the medicinal preparations in the treatment of such diseases.

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