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A Review on Phytochemistry, Pharmacology and Botnical Aspectsof Tribulus Terrestrisin The Search For Moleculeswith Bioactivepotential

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Abstract
Tribulus terrestris(family Zygophyllaceae), generally known as Gokshur or Gokhru or perforation vine, hasbeen used for a long time in both the Indian and Chinese systems of drug for treatment of colorful kinds ofconditions. Its colorful corridor contains a variety of chemical ingredients which are medicinally important,similar as flavonoids, flavonol glycosides, steroidal saponins, and alkaloids. It has diuretic, aphrodisiac,antiurolithic, immunomodulatory,antidiabetic,immersionenhancing, hypolipidemic,cardiotonic,centralnervoussystem,hepatoprotective,anti-inflammatory,analgesic,antispasmodic,anticancer,antibacterial,anthelmintic,larvicidal,andanticariogenic conditioning.Forthelastmanydecadesorso,expansive explorationworkhasbeendonetoproveitsnaturalconditioningandthepharmacologyofitsexcerpts.The endofthis review is toproduceadatabaseforfurtherexaminations ofthediscoveredphytochemicalandpharmacological parcels of this factory to promote exploration. This will help in evidence of its traditional usealongwithitsvalue-addedmileage, ultimatelyleadingtoadvancedearningsfromthefactory.[1]

Keywords:- Tribulus terrestris L., Antioxidant activity, Radical scavenging, Lipid peroxidation inhibition,Polyphenols,saponin[2]

I. Introduction

Tribulus terrestris L. (Zygophyllaceae) (TT), also known as pit vine, is a worldwide perennialcreeping herb.Since ancient times, it has been considered an aphrodisiac in Bulgarian Sophoma AD, in addition to itsbeneficial effects on various ailments such as urinary tract infections, inflammation, edema, and ascites.TribestanTM consists of an n-BuOH extract of the aerial parts of the same plant and has been used to treatsexual impotence2. The active ingredient in Trivestan TM is a steroidal saponin of furostanol type 2-4. Thepredominant furostanol glycosides were identified as protodioscin and protogracillin-4. Intensive screening ofthe qualitative and quantitative composition of raw materials of TT and numerous preparations of variousorigins showed that the Bulgarian preparation TribestanTM contained the highest amount of protodioscin andprotogracillin5.TheaphrodisiacpropertiesofTTextractshavebeenstudiedincastratedrats6.Administration of TT in humans and animals improves libido and spermatogenesis 7. Protodioscin has also been found toincrease levels of testosterone, luteinizing hormone 7, dehydroepiandrosterone 8, dihydrotestosterone, anddehydroepiandrosterone sulfate 9.Clinicalstudies have shownthat TT improves reproductive function,including increasing levels of hormones such as estradiol, and has a small effect on testosterone, therebyimprovingreproductivefunction,libido,andovulation4,10.Electronsthatcanoxidativelymodifybiomoleculestheyencounter.Theyreactalmostinstantlywithanythingintheirenvironment,initiatingachainreaction that leads to cell damage 11. Oxidative damage caused by reactive oxygen species (ROS) is associatedwith arthritis, cancer, inflammation, and heart disease 12 and contributes to defective spermatogenesis leadingtomale infertility.

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Plantprofile

Tribulus Terrestrisin is generally known as Gokshur(Sanskrit); perforation vine, land(or small) caltrops(English); Gokharu(Hindi); Bethagokharu or Nanagokharu(Gujarathi); Nerinjil(Tamil); and Khar-e-khasakkhurd(Urdu).It'sdistributedalonga widegeographicborder.It'sset upeachoverIndiaupto,000ftinKashmir,Ceylon, and all warm regions of both components. It's a common weed of the pasturage lands, road sides, andotherwasteplaces,primarilyinhot,dry,andflaxen regionsincludingWestRajasthanandGujaratinIndia.[4]

Traditionaluses

TT is used in folk medicine as a tonic, aphrodisiac, emollient, astringent, tonic, antihypertensive, diuretic,lithotripsy, and urinary antiseptic. Herbal dried fruits are very effective for most diseases of the urogenitalsystem. It is a key ingredient in Gokushlaj Guggul, a powerful Ayurvedic medicine used to support the properfunctioning of the genitourinary tract and remove urinary tract stones. TT has been used in Ayurveda forcenturies to treat impotence, sexually transmitted diseases and sexual weakness. In Bulgaria it is used as a folkmedicine for the treatment of impotence. In addition to all these uses, the Indian Ayurvedic Pharmacopoeiaconsiders the root and fruit to have cardiotonic properties. In traditional Chinese medicine, the fruit has beenusedtotreateyeproblems,edema,bloating,discharge,abnormalfluoride,andsexualdysfunction.Pharmacological Work), it is described as a drug of great value in the treatment of liver function restoration,chest bloating, mastitis, flatulence, acute conjunctivitis, headache, and vitiligo. In Unani medicine, TT is usedas a diuretic,mildlaxative,andgeneraltonic.[6]

PhytochemistryofTribulusTerrestris

The chemistry of T. terrestris has been extensively studied, and the presence of saponins, flavonoids, alkaloids,lignanamides and cinnamamides has been reported in T. terrestris (Saleh et al., 1982; Bourke et al., 1992; Renet al., 1992; Ren et al. al., 1994; Lee et al., 1998). This plant is very rich in potentially biologically importantsubstances.

saponins, flavonoids, alkaloids and other nutrients (Wang et al., 1997). The amount and presence of these keymetabolitesvarywiththedifferentplantpartsused.The fruitsandrootsofT.terrestriscontainpharmacologically important metabolites such as plant steroids, flavonoids, alkaloids and glycosides (Wu etal., 1996). A large number of different saponins and their various derivatives have also been identified in T.terrestris, of which diosgenin, gitogenin, and chlorogenin are found in leaf tissue. The presence of spirostanoland furostanol saponins is characteristic of this plant, the latter being thought to be the biogenetic precursor ofspiroanalogues(Mahatoetal.,1982).Variousderivativesoftigogenin,neotigogenin,gitogenin,neogitogenin,hecogenin, neo hecogenin, diosgenin, ruscogenin, chlorogenin and sarsasapogenin are found. Four sulfatedfuro- and spiro-saponins have also been isolated. In general, saponins, flavonoids, alkaloids, lignanamides, andcinnamic acid amides are of therapeutic value, of which spirostanol and furostanol saponins are the maincomponents (Kostova & Dinchev, 2005). Many pharmaceuticals and dietary supplements are marketed basedontheirsaponincontent.

Thesaponincompositionwascorrelatedwith theplaceoforigin.Thisapproachrevealedinterestingdifferencesnotonlyinthetypesofsaponins,butalsointhetypesandnumbersofsaponinsugarsinplant samplescollectedfrom different geographical regions. The content of protodioscin also varies depending on the collection area.This is consistent with the considerable product-to-product variability observed in the protodioscin content ofsaponin fractions of T. terrestris available as commercial products and requires proper standardization. Thefreshlysqueezedjuiceoftheaqueousextractofthewholeplantcontainsinorganicnitrates,primarilypotassiumnitrate. The diuretic action of plants is due to nitrates. Fruit contains alkaloids, resins, fats, ascorbicacid,minerals(14%)andessentialoils.Theamountofascorbicacidin T.terrestrisincreasesfromroottofruit.

T.Tribulusterrestrisisalsorichiniron.SeeFigure2forthechemicalstructureofspirostanol andFigure3forfurostanolsaponins.[10]

Variation in saponin composition and content with geographical regions:- A review of literature datarevealed some differences in saponin content and composition in T. terrestris growing in different geographicregionsoftheworld (Kostova&Dinchev,2005).Phytochemically,T.terrestrisfrom China,IndiaandBulgariahave been studied, and there are limited phytochemical analysis reports of T. terrestris from Turkey, Moldova,SouthAfrica,Australia,AzerbaijanandRomania.Forexample,saponinswithcisA/Bringbonds

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(gitogenin/neogitogenin types) are found only in T. terrestris of Chinese origin (Xu et al., 1998; Kostova &Dinchev, 2005). Diosgenin-type spiro saponins have been reported to be found in T. terrestris from Bulgaria,Moldova,Romania,Turkey,andSouthAfrica (Tomovaetal.,1974;Miles etal.,1993).

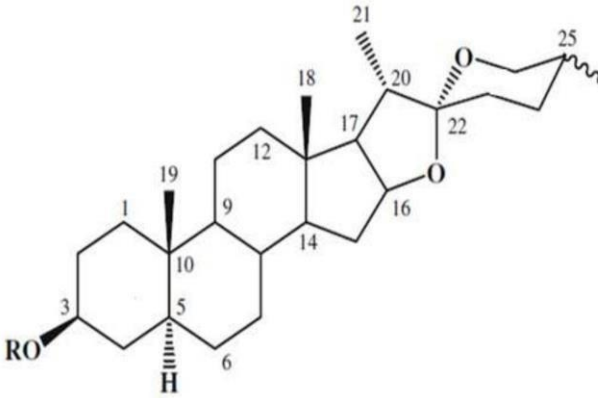

Fig 1:-
Chemicalstructureofatypicalspirostanolsaponin

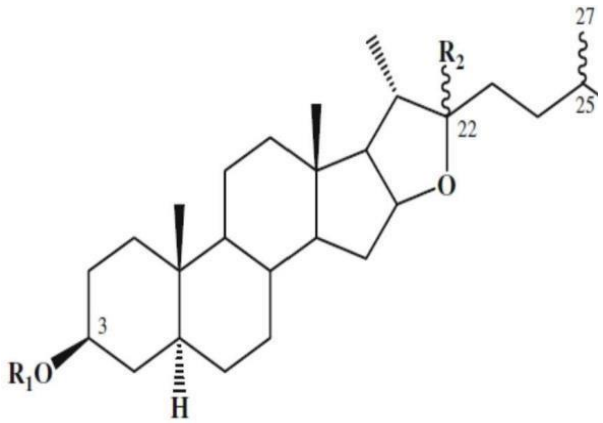

Fig2:-Chemicalstructureoffurastanolsaponin

Phytochemicalinvestigations

Many different compounds with different biological properties and chemical structures have been identifiedfrom TT, including steroidal saponins, flavonoids, glycosides, phytosterols, tannins,terpenoids, amidederivatives, amino acids and proteins. Among the various classes of components, steroidal saponins andflavonoidsareconsideredtobethemostimportantm etaboliteswithvarious biologicalactivities.[20]

PlantMorphologyOfTribulusTerrestris

Tribulus terrestris is an annual (sometimes perennial in temperate climates) herb with a long, thin, branchedtaproot. The greenish-red stems are up to 2 m long, branched, radiating from the central axis and coveredwith fine hairs. It usually prostates, but the stems become more erect in shade or when competing with otherplants [19]. The leaves are 3 to 7 cm long and opposite, with one pair slightly smaller than the other. Eachleaflet consists of 3–8 pairs of opposed oval-lanceolate bilateral leaflets with a length of 5– 15 mm and awidth of 3–5 mm [20]. The flowers are 4-10 mm in diameter, with 5 sepals, 10 stamens and 5 yellow petals.Thepetalsare7–15mmindiameter,solitary,onshort stalksintheaxilsofsmallleaves. Thefruitisawoodyburrabout1cmindiameterdividedint ofourorfivewedge-shapedsegments(carpels),eachwithtwounequalspines (also called nuts). Nuts have a striking resemblance to a goat's or bull's head. The "horns" are sharpenoughtopierceabicycletireorlawnmowertire.E venwalkingbarefootcanleadtopainfulinjuries.Each nutley contains 1-4 seeds stacked on top of each other and separated by a hard membrane. The seeds areyellow, vary in shape, more or less ovoid, and 2 to 5 mm long. As an adaptation to dry climates, the largestseedsmaygerminatefirst,whileotherswaituntil moremoistureisavailablebeforegermination.[22]

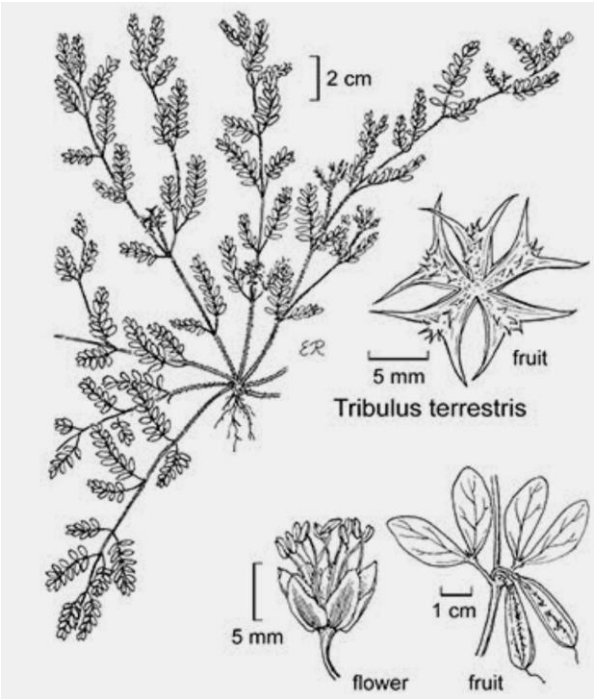

Fig 3:-OverviewofTribulusTerrestris plant

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MedicinalUsesof*T.terrestis*

Tribulus terrestris has been used medicinally since ancient times. T. terrestris is used in Ayurvedic, Unani, andtraditionalChinesemedicine,whereitisknownasgokshura(Sanskritforcow'shoof),karekasakkool,andbaiji lee, respectively. In India and China, the medicinal use of this herb can be traced back to his 5,000 years.InAyurvedic pharmacology, Tribulus terrestris (also known as Gokshura) is used as an aerial part, especially infruit powder form, for healthy urine flow and helps calm the allantosis. It acts as a tonic for healthy spermproduction.It helps rejuvenate the uterus and other organs responsible for pregnancy in women.Its saponin andflavonoidcontentcontributestohealthyspermproduction.Contribute,maintainhormonelevels,calmthemind.Helps cleanse the blood and improve itching in the body. Helps shift down bloating. It is also known tohavediureticproperties.InAyurveda,thisherbisknownforitsdiuretic,aphrodisiacandanti-urolithiasisproperties.In traditional Chinese medicine, its berries have been used to treat eye problems, bloating, discharge,edema,abnormalfluoride,sexualdysfunction,andveil.Itisrecommendedintheformofherbaltonicsforailments.InBulgarianfolkmedicine,T.terrestrisisuseddforbloodpurificationandinhaemorrhoids.Ithasbeenreportedthatthe seeds or nutlets have been used in homicidal weapons smeared with the juice of Acokantheravenenata insouthern Africa. Tribulus is used for kidney problems, including kidney stones, painful urination, a kidneydisorder called Bright's disease, and as a “Water Pill” (diuretic) to increase urination; for skin disorders,including eczema (atopic dermatitis), psoriasis, and scabies; for male sexual problems, including ErectileDysfunction(ED),involuntaryreleaseofsemenwithoutorgasm(spermatorrhea),andtoincrease sexualdesire;forheartandcirculatorysystemproblems, includingchestpain,highbloodpressure,highcholesterol,and “TiredBlood(anemia);forproblemswithdigestion,including colic,intestinalgas(flatulence),constipation,and to expel intestinal parasitic worms; forpain and swelling (inflammation) of the tissue lining the mouth(stomatitis)andsorethroat;andforcancer,especiallynosetumors.WomenuseTribulustotonemusclesbeforechildbirth, to cause an abortion, and to stimulate milk flow. Some people use Tribulus for gonorrhea, liverdisease (hepatitis), inflammation, joint pain (rheumatism), leprosy, coughs, headache, dizziness (vertigo),Chronic Fatigue Syndrome (CFS), and enhancing athletic performance. It also stimulates appetite and is usedas an astringent, tonic and mood enhancer. Tribulus contains chemicals that increase hormones in animals.However,itdoesnotappeartoincreasethemalehormone(testosterone)inhumans.Somebodybuilders use T. terrestris as a post cycle therapy or "PCT". It is used under the assumption that it restores the body's naturaltestosterone levels after completing an anabolic steroid cycle. This extract is said toincrease the body's naturaltestosteronelevels,therebyimprovingsexualperformanceinmenandhelpingbuildmuscle.Itsclaimed muscle-buildingpotentialdatesbackto1970.Itwaspopularized byJeffreyPeterman,hisIFBBbodybuildingchampionin America in the early 80s. However, T. terrestris failed to increase testosteronelevels in controlled studies. Italsofailedtodemonstratestrength-enhancingproperties.Thissuggeststhattheallegedanabolicsteroideffectsof terrestris are not true. Some users have reported stomach upset, which is usually resolved by taking it withmeals.[27]

TraditionalPharmacologicalUsesofTT

TT is native to southeastern and Mediterranean Europe, temperate and tropical Asia and Africa, and northernAustralia. The use of TT since ancient times has been in traditional medicine of important cultures in thefollowing geographic regions: B. Traditional Chinese Medicine, Traditional Indian Medicine (Ayurveda), andTraditionalMedicineofSouth-EasternEurope,whichdefineitsethnopharmacological relevanceasamedicinalplant. As a traditional Chinese herbal medicine, it was listed as a major medicine in Shennong Ben Cao Jing,the oldest extant Chinese medicinal monograph. In the Chinese Pharmacopoeia, TT fruit is used to tone thekidneys, as a diuretic and expectorant to improve vision, and to treat itchy skin, headaches, dizziness, and ductalcongestion.InIndia,thefruithasbeenusedinAyurvedatotreatinfertility,impotence,erectiledysfunction, andlowlibido.Cardiotonicpropertiesarealsoattributed totherootandfruit.[21]

PharmacologicalPropertiesOfTT

Pharmacokinetic properties of TT major compounds Protodioscin is the major component of TT fruit and isconsideredtobethemostimportantpharmacologically activesteroidalsaponin.Studiesonthepharmacokinetic properties of protodioscin have yielded conflicting results. A recent study by Zhang et al. concluded thatprotodioscinhaspoorinvivobioavailability.Howe

ver,thesamegroupofauthorsshowedthatthepharmacokinetic profile of protodioscin showed good bioavailability after administration of extract fromDioscorea japonica. Despite several in vivo studies on TT, little is known about the pharmacokinetics oftherapeuticallyactivecompounds.However,therearepharmacokineticstudiesofprotodioscinanddioscinafteradministrationofdifferentDioscoreaspecies.excerpt.Saponinsaremembranepermeableduetotheiramphipathicmolecules,whichmayincreasetheabsorptionofothercompounds.Thispropertyisveryimportantastoxiceffectscanoccurinpatientswithmultiplediseases undergoingchronictreatment.[24]

BotanicaldescriptionofTT

T. terrestris is a small, silky, hairy herb with stems up to 2 m long. The leaves are pinnate, short (about 1.25 cmlong), opposite, each composed of 4-8 pairs of lanceolate leaflets. T. terrestris is characterized by small (8-15mm diameter) yellow petals and spiny fruit. The fruit is a woody burdock with a diameter of about 1 cm andsharpspikesabout6mmlong.Theridgeconsistsoffivewedge-shapedsegments.Eachsegmenthastwounequalpairs of spines. The seeds are surrounded by a woody star-shaped structure (carpel) about 5-7 mm long and 5-6mm wide. Each carpel has up to 5 seeds, each 1.5-3 mm long and yellow in color. Each plant can contain up to2000 seeds. It's astringent and comfortable. Fresh roots are thin, fibrous, cylindrical, and light brown in color.StomatainT. terrestrisareanomoocytesinwhichtheguardcellsarenotsurroundedbyaccessorycells.[15]

Miscellaneoususes

Lin et al., (1999) studied the use of T. terrestris berries to treat vitiligo with positive results. A lyophilizedsaponinmixtureofplantssignificantly reducedperistalsisinisolatedsheepureterandrabbitjejunumspecimens,suggestingthatthesaponinmixturemaybeusefulinsomesmoothmusclespasmsorcolic.(Arcasoy etal.,1998).ThepreventiveandtherapeuticeffectsofT.terrestrissaponinsondiet-inducedhyperlipidemiainmice were investigated. Saponins have been shown to decrease serum TC, LDLc and liver TC, TG levels andincreasehepaticsuperoxidedismutaseactivity(Chu etal.,2003). Thehypoglycemiceffectsofsaponinsfrom T.terrestrishavebeenstudiedandfoundtosignificantlylowerserumglucose levels(Lietal., 2002).[29]

II. Conclusion

The herb T. terrestris is well known and used in many countries as a folk remedy for various ailments. Thisplant is characterized by its high content of steroidal saponins. Various derivatives such as tigogenin, neotigogenin,gitogenin,neogitogenin,hecogenin,neohecogenin,diosgenin,ruscogenin,andchlorogenin.Sarsasapogenin are found in different parts of this herb originating from different regions. Oligosaccharidescontain sugars: glucose, rhamnose, galactose, xylose. This plant is an industrial source for the production ofpharmaceuticals based on its saponin fraction. Dietary supplements claiming to have a general stimulatingeffect are now also marketed in Europe and America.T. terrestris remains a plant subject to further research.Meanwhile, the saponin composition of this plant collected only in China, India, Bulgaria and Moldova hasbeen well studied. Literature data show that the saponin composition and saponin content of T. terrestris fromdifferentgeographicalregionsaredifferent.Studiesontherelationshipbetweenplantmorphologyandsaponincomposition are needed to explain the reasons for the observed differences. Further investigation on thebiological activity of the extracts and individual compounds is of particular interest. The biodiversity of thisplant at the molecular level has not yet been studied in detail and needs further study. Little information isavailable on molecular markers. Similarly, few genomic studies of this important plant have been performedandhisESTdatabase forT. terrestrisisnotavailable.[30]

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