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TERMINALIA ARJUNA: A COMPREHENSIVE REVIEW ON PHYTOCHEMISTRY, THERAPEUTICS USES AND CLINICAL INSIGHT

SIDDHANT SANKHE[1], HARSHALI THAKARE[2], SONALI UPPALWAR[3]

Ideal Institute of Pharmacy
Posheri Pimplas village, Tal.wada, Dist. Palghar 401404

Abstract:
The components of digestive churna from ancient culture include ashoka, arjuna baheda, and harde. These medications primarily contain tannins, which are abundant in the manufacturing area. It is a polyphenolic emulsion with chemo-defensive potential and demonstrated antioxidant properties. They are arranged in dinghy, leaves, flowers, and fruits.The goal of the study is to use the folin-denis method to quantify the amount of tannins present in these medications. Crushed to coarse greasepaint were Terminalia chebula (combretaceae) (harde), Terminalia belerica (combretaceae) (bahera), Terminalia arjuna (combretaceae) (arjuna), and Saraca indica (leguminaseae) (ashoka).The folin-denis technique was used to make the alcoholic extracts of the medications for photometric tannin analysis. The tannin content was established to be 99.55456 mg/gm, 9.95568 mg/gm, 54.96288 mg/gm, and 57.4869 mg/gm for Harde, Arjuna, Baheda, and Ashoka separately based on the standard graph of tannic acid results.Tannic acid's attention wind was identified, and the correlation coefficient was computed and set at 0.998, indicating a good linear relationship between attention and absorbance. It has been established that the tannins disrupt the bacterial enzymes' metabolic activity, nutritional vacuity, and natural membrane functionality in order to create stable complexes with protein, bounce, and essence chelates.The current study can serve as one of the criteria for standardizing pharmacies. [6]

Key words: Tannis, Terminic acid, Galic acid , Arjunolic acid, Terminalia beleria, Terminalia chebula, flavonoids, Triterpenoid.

INTRODUCTION:

The Combretaceae family includes the implicit cardioprotective agent Arjuna. Astang Hridayam, Sushruta Samhita, Charaka Samhita, and other ancient Indian medical texts have all made reference to this ayurvedic treatment since the Vedic era. Vagabhatta was the one who initially advocated for the application of stem dinghy greasepaint in heart affections.[1]The most promising new chemotherapeutic drug to be created for the treatment of cancer in the last ten years is taxol, one of the most recent discoveries. Recent clinical trials have demonstrated that taxol may also be helpful in treating non-small-cell lung cancer, head and neck cancer, and various other types of the disease. It has already been demonstrated to be genuinely effective against ovarian and bone cancer. Initially, researchers searched for taxol in other Taxus species or in other Taxus brevifolia corridors, such as the Pacific or Western yew.Along with T. cuspi ata (Japanese yew), T. baccata (English yew), T. canadensis (Canadian yew), T. floridana (Florida yew), T. chinensis (Chinese yew), and T. media (Anglojap yew), taxol and related taxa were also established in the shoots of individual trees from the majority of the taxa examined. The issue is that each cancer treatment may require kilograms of beach towel in terms of the amount of taxol required.This method is still multi-step, and the total yield has rendered it commercially unviable. Therefore, other strategies to capitalize on this medication's worth must be established. One of the most widely insulated endophytic fungal species, according to Li et al., is Pestalotiopsis microspora from the bald cypress (Taxodium distichum) in South Carolina, USA. It was set up to manufacture taxol based on

the responsiveness of partially purified culture extracts.The taxol product by a non-plant associated fungus is supported in this research, and it is suggested that other industrial species that live in specific wet environments might also be hosts to similar taxol-producing endophytes. Therefore, a microorganism-based turmoil process would be the most desirable and appropriate method of supply to reduce the cost of taxol and increase its availability. Information about the webbing of endophytic fungus that produce taxol from tropical medicinal factory species is incredibly limited.To the best of our knowledge, this research is the first to report on a taxol product produced by a fungal endophyte of a Southern Indian medicinal factory that uses the arjun tree (Terminia arjuna (Roxb.) Wight & Arn). There are some pharmaceutical packages in this factory. The dinghy has antiproliferative properties, is styptic, alcohol, febrifuge, antidysenteric, and works as a diuretic in liver cirrhosis.[13]

MATERIALS AND METHODS:

Preparation of aqueous extract of T. arjuna:

StembarkofT.arjuna, obtainedfromthe southernpartof India(Madurai quarter, Tamilnadu) during the months of September/ October, was authenticated by the Department of Pharma cognosy, Pharmaceutical Technology, Jadavpur University, Kolkata, India(vide testimonial instance no. 53). The dried pulverised greasepaint of the dinghy was uprooted with double distilled water(DDW) by hot nonstop percolation using Soxhlet outfit for 72 h. The excerpt was also filtered and lyophilised. A 25 yield was attained following birth. The waterless excerpt of T. arjuna dinghy was estimated qualitatively for the presence of glycosides, flavonoids, polyphenols, saponins and terpenoids.[28]

Quantitative evaluation of the aqueous extract of T. arjuna by TLC:

The presence of arjunolic acid and terminoic acid in the excerpt was determined by TLC using tolueneethylacetateformicacid(730.5v/v)asthesolventsystem.Standardsolutionsofarjunolicacidandtermino icacid(both1 mg/ ml) wereprepared. Lyophilised waterless excerpt of T. arjuna(250 mg) was uprooted four times with 10 ml n- butanol and the final volume made up to 50 ml. Samples of this result and a standard result(10 ml of each) were applied to a precoated silica gel 60F254 plate(E. Merck, Darmstadt, Germany) of invariant consistence(0.2 mm). The plate was developed in the solvent system up to a distance of 8 cm and observed under 254 nm, UV 366nm. TheRfvalues of the bands resolved were noted. Derivatisation was done with anisaldehyde sulfuric acid reagent followed by hotting for 10 min at 100 °C and the Rf values of the bands noted.[28]

Animals:

The study was approved by the Institute Animal Ethics Committee(blessing no. 289/ IAEC/ 05) and all beast care and experimental protocols were in compliance with the US National Institutes of Health Guidelines for the Care and Use of Laboratory creatures(NIH Publication# 85- 23, 1985). Laboratory-bred manly Wistar rats(150 – 200 g, 10 – 12 weeks old) were maintained under standard laboratory conditions of 25 ± 2 °C, relative moisture 50 ± 15 and normal 12 h light dark cycle. marketable bullet diet(Ashirwad, Chandigarh, India) and water were handed announcement libitum.Ratswererandomly distributed into groups of six rats for the trial.[8]

Experimental protocol:

Appropriate amounts of T. arjuna dinghy waterless extract were dissolved in a suitable amount of DDW and given orally by gavage at 63, 125, and 250 mg/kg previously every day for 28 days. Based on previous research conducted in our lab on the cardioprotective properties of T. arjuna dinghy, these boluses were given their names; the yield was used to determine the appropriate cure for the waterless extract.[11]In order to produce LVH, these three groups of rats were additionally given isoprena line (5 mg/kg, s.c.) daily for 28 days. Every day, one group took simply isoprenaline. For 28 days, a positive control group received isoprenaline and captopril (50 mg/kg) orally by gavage. For 28 days, the control group received a daily intravenous dose of normal saline (1 ml/kg). Measurements of body weight, food intake, and water intake were made every seven days. All groups' animals were anesthetized with ketamine HCl 50 mg/kg

and xylazine 10 mg/kg, intraperitoneally, at the conclusion of the 28-day experimental phase, and echocardiography was carried out as detailed below.Additionally, rats were put to death by an overdose of ether anesthesia, and their hearts were collected, briefly cleaned in ice-cold saline, patted dry with a paper kerchief, and then counted. For biochemical evaluations, the right ventricular towel and atrial accessories were kept apart and kept in liquid nitrogen. For light-bitsy investigations, heart samples were kept in 10 softened formalin (pH 7.2).[28]

Chemicals:

All chemicals were of logical grade or advanced and were attained from Sigma Chemicals(St Louis, MO, USA), exceptL-4-hydroxyproline, which was from Fluka(Steinheim, Germany) and detergents, which were from Merck(Mumbai, India). DDW was used for all biochemical assays.[8]

Antimutagenic activity:

Antimutagenic activity screening using mouse bone marrow Animals in nine groups (n=6) were randomly assigned to the following groups for the micronucleus test. Group 1 was a normal control group that did not receive cyclophosphamide, the test drug, or either; Group 2 was a vehicle-treated group that received 2% Acacia (10 ml/kg); and Group 3 was a positive control group that was challenged with cyclophosphamide (i.p. 75 mg/kg). Bone marrow was extracted from these animals 24 hours after the cyclophosphamide injection.Group 4 was used as a positive control; they were given cyclophosphamide (i.p. 75 mg/kg) and had their bone marrow extracted 48 hours following the injection. Group 5 was used as a positive control; they were given cyclophosphamide (i.p. 75 mg/kg) and had their bone marrow extracted 72 hours after the injection.For seven days in a row, the animals in Group 6—which served as the extract control—were given oral Terminalia arjuna extract at a dose of 100 mg/kg. Terminalia arjuna extract together with vehicle (100 mg/kg) was administered orally to Group 7 for seven days in a row. On the seventh day, cyclophosphamide (i.p. 75 mg/kg) was given as a challenge. Following an infusion of cyclophosphamide for 24 hours, bone marrow was extracted.For seven days in a row, Group 8 received oral Terminalia arjuna extract (100 mg/kg), and on the seventh day, they were challenged with cyclophosphamide (i.p. 75 mg/kg). Following an infusion of cyclophosphamide for 48 hours, bone marrow was extracted. For seven days in a row, Group 9 received oral Terminalia arjuna extract with vehicle (100 mg/kg), and on the seventh day, they were challenged with cyclophosphamide (i.p. 75 mg/kg). After being injected with cyclophosphamide for 72 hours, bone marrow was extracted.As previously reported, all of the animals were put to sleep at the end of the experiment, and the bone marrow was extracted from the femurs and placed in 1 milliliter of 5% bovine albumin in phosphate buffered saline (pH 7.2). [13, 17, 19] Smears were made from the pellet on chemically cleaned glass slides and stained with May-Gruenwald Giemsa after the cell suspension was centrifuged for five minutes at 1000 rpm [12]. Using the oil immersion objective, the smears were examined, and 2000 polychromatic erythrocytes (PCEs) per animal were counted.Concurrently encountered normochromatic erythrocytes (NCEs), micronucleated PCEs (MNPCEs) and micronucleated NCEs (MNNCEs) were also counted. [61]Statistical analysis:

Six animals' mean ± SEM values were reported. One-way ANOVA will be used to assess the statistical difference in mean, and Turkey's multiple comparison tests will come next. A significance level of $P < 0.05$ was deemed statistical. [38]

ANTIBACTERIAL ACTIVITY:

The antibacterial activity of the factory-intermediate Au NPs was evaluated against common lethal infections, specifically S. aureus (NCIM 5021), P. aeruginosa (NCIM 5029), and S. typhimurium (NCIM 2501). Pure bacterial colonies were softly spread out on sterile nutrient agar plates to test the antibacterial action. A sterile cork borer was used to create the 10 mm peripheral wells on the nutrition agar plates. T. (19) arjuna splint extract was used as a control, whereas 100 µL of green manufactured Au NPs was injected to the well. The inhibition zones surrounding the wells were measured in millimeters (mm) after a 24-hour period.Our suggested data is also supported by other studies on Au NPs conflation from T.

arjuna production. The structure of Au NPs was further confirmed by UV Vis spectroscopic investigation.[27]

PHYSICO-CHEMICAL CHARACTERIZATION:

The generation and stability of Au NPs in aqueous solution were verified using the UV-Vis spectrophotometer. UV-Vis spectroscopy was used to examine the mixture of leaf extract and HAuCl4 solution. Pure Au3+ ions were bio-reduced using T. arjuna leaf extract.

Sr. No	Test	Result
1.	Moisture content	10.19 ± 1.30a
2.	pH	4.13 ± 0.06b
3.	Total Ash	17.49 ± 1.31a
4.	Water soluble extractive	20.50 ± 0.66a
5.	Alcohol soluble extractive	28.48 ± 3.71a

Table No 1: Physicochemical parameters of T. arjuna stem bark[26]

The optical absorbance of Au NPs dispersed in distilled water was measured using the UV-Vis Spectrophotometer (UV-Vis 1601 Schimodzu spectrophotometer, Kyoto, Japan) in the 200–800 nm wavelength range. The reaction was monitored by periodically sampling the 1 mL aliquots. The sample was examined using a Philips CM 200 transmission electron microscope (TEM) to ascertain the size and shape of the biosynthesized Au NPs produced by T. arjuna (Philips, Amsterdam, The Netherlands).The apparatus was operated at an accelerating voltage of 200 kV and has a resolution of 0.23 nm. To get the solvent to evaporate, a drop of the solution was placed on a carbon-coated copper grid and exposed to infrared light for forty-five minutes.

The pH, total ash content, and loss after drying at 105 oC are the primary factors affecting the stability of herbal plant material. Generally speaking, for better drug stability, a low moisture content is ideal. In the current investigation, TASB showed a low moisture content, falling within the recommended range of 8% to 14%. The pH of the TASB is acidic.Because it had more carbonate, phosphate, oxides, silicates, and silica particles, its ash value was higher. Higher extractive values for alcohol and water were found in the TASB, suggesting thepresence of highly polar chemical elements like proteins, carbohydrates, flavanoids, and phenolic compounds. The findings of the physiochemical analysis, macroscopy, and microscopy are consistent with the Indian Ayurvedic Pharmacopoeia. [26]

PHARMACOGNOSTIC FEATURES :

The external face of the dinghy is smooth, while the inner face has longitudinal striation and is pinkish in color. [2] The dinghy gets f laked off itself in the month of April – May. On bitsy examination of the mature dinghy, a cork correspond ing of 9 10 layers of parenthetically stretched cells, 2 4 cells thick phellogen, and phelloderm conforming of parenthetically stretched cells are seen. The phloem is broad, conforming of ceratenchyma, phloem parenchyma, phloem filaments, and demitasse filaments with ensign chargers of calcium oxalate. Periderm and secondary phloem are present in the old dinghy. Leaves are sub contrary, coriaceous, oblong/ elliptic, dull green from the upper side and pale brown on the lower side, frequently unstable sided with 10 15 dyads of jitters. Flowers are white in color and bisexual, arranged in harpoons with direct bracteoles Fruits are elliptical / oblong with 5 7 hard angles or bodies. The lines on bodies are oblique and curving overhead. Major chemical ingredients of arjuna. colorful excerpts of the stem dinghy of arjuna have shown to retain numerous pharmacological parcels including inotropic, anti ischemic, antioxidant, blood pressure lowering, antiplatelet, hypolipidemic, antiatherogenic, and antihypertrophic. therefore, in the present composition, we've made an attempt to

review and give up to date information material to the operation of arjuna as a implicit cardioprotectiveagent[2]

Fig No 1: Terminalia arjuna tree bark [26]

EXPERIMENTAL STUDIES:

Effects on cardiac hemodynamics, coronary flow, and blood pressure

The bark stem of Arjuna has chronotropic, inotropic, and diuretic qualities. It has been shown that the aqueous extract increases coronary flow in the Langendorff's rabbit heart preparation. The aqueous extract of arjuna was found to increase the force of contraction of cardiac muscle in frog's heart in situ, hypodynamic frog's heart in situ, and isolated perfused rabbit heart, which supports the prior findings. The isolated perfused dose-dependent drop in blood pressure was accompanied by an increase in coronary flow. Singh et al. found that dogs' blood pressure and heart rate decreased in a dose-dependent manner when given an aqueous solution containing 70% alcoholic bark extract; however, the exact mechanism was unknown. [22]Takahashi et al. showed that the hypotensive effect of arjuna was seen with a proportion of tannin-related chemicals extracted from the aqueous extract. This effect was not impacted by rats being pretreated with propranolol, but it was weakened by atropine. This implied that cholinergic pathways might be involved in the hypotensive impact. Later, it was reported that the 70% alcoholic extract caused peripheral, dose-dependent hypotension, which could be caused by direct action on the heart muscle or agonistic effects on the adrenergic β2 receptor.It was also hypothesized that the hypotension generated is unlikely to be caused by muscarinic or histaminergic mechanisms. According to a recent study, the safety and effectiveness of arjuna bark in cardiac therapy may depend on the way it is administered and/or whether the hydrophobic components are specifically left out of the bark powder. [52]

Macroscopic study of TASB:

The dinghy is gray and smooth externally, internally brown or red coloured and smooth. The shape of dinghy was flat and twisted. The obliquely cut dinghy showed brownish face, fracture, short in inner and laminated in external part. The greasepaint of TASB was light brown with tangy taste and no odour. [26]

Microscopic study of TASB section:

Bitsy evaluation is one of the cost effective and simplest styles for the correct identification of the factory material. Transverse section of fresh stem dinghy showed typical anatomical characters. It had external cork region composed of slightly arranged several layers of small, parenthetically stretched cells. The region of cortex, composed of thin walled, more or less slipup shaped parenchymatous cells containing cluster chargers of calcium oxalate and many groups of sclerenchymatous pericyclic fibres with scattered arrangement were observed below the cork region. The inmost region showed presence of secondary phloem conforming of thin walled, polygonal cells with crimpy walls containing cluster chargers of calcium oxalate and painted cells. [41]

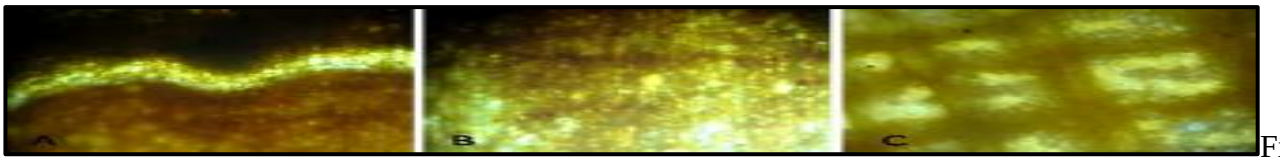

Fig no. 2: Microscopic photo of T. arjuna stem bark, A- outer region, B- inner region C- magnified inner region[41]

MICROSCOPY OF POWDER:

Uniseriate phloem rays, fibers, irregularly shaped reddish-brown particles, and many white rosette crystals of calcium oxalate were all visible in the unstained TASB powder when seen under a light microscope at a 10x magnification. Following staining with 0.2% phloroglucinol, pink-colored fibers emerged. This demonstrated that there was lignified material there. Following staining with a 0.2% iodine solution, violet-colored granules with elliptic or round to oval shapes and two to three components displayed concentric striations. This verified the presence of starch. TASB material identification may benefit from this microscopic examination of the powder. [41]

Treatment	Visible light	UV light
Powder	Brown	Greenish brown
Powder + water	Red	Black
Powder + 1N NaOH	Red	Blackish brown
Powder + 1N NaOH (alc.)	Yellowish brown	Black
Powder + Ammonia	Dark red	Black
Powder + 50 % HCl	Yellowish Red	Black
Powder + 50 % H2SO4	Dark brown/black	Black

Table NO. 2: Fluorescence analysis of TASB powder under visible and UV light after treated with different reagents/solvents[28]

Fig No. 3: Microscopic photo of Powder of T. arjuna stem bark powder, A- without stain, B- stained with 0.2 % phloroglucinol, C- stained with 0.2 % iodine[41]

Fluorescent evaluations of TASB powder:

For the initial line of standardization of crude drugs, fluorescence analysis is a crucial metric.TheTASB powder looked red, dark brown to yellowish brown in most of the reagents, and pale yellow in ethyl acetate when exposed to visible light. In the majority of the reagents, the TASB powder appeared black under prolonged UV illumination; in a small number of reagents, it appeared dark brown to greenish brown. [28]

MACROSCOPIC CHARACTER TREE:

TREE: It is moderate tree having thick bark.

LEAVES: Terminalia Arjuna contain simple and smooth leaf.

FRUITS: Fruits are obovoid - oblong dark brown fibrous woody indehiscent drupe.

INFLOURESENCE: Terminalia Arjuna the inflorescences are short axillaries spikes or small terminalpanicles.

FLOWER: Flower is small regular, sessile cup shaped polygamous, white creamy or greenish white androbustly honey scented.

POWDER: The powder of Terminalia Arjuna containing yellowish white. [61]

Fig No.4: Arjuna Tree[61]

Fig No.5: Arjuna Leave[61]

PRE-CLINICAL STUDIES:

Kokkiripati et al. assessed the molecular basis of T. arjuna stem bark's cardioprotective potential utilizing human monocytic (THP-1) and human aortic endothelial cell cultures (HAECs). arjuna stem bark were tested for their ability to inhibit lipid peroxidation, lipoprotein lipase (LpL), and human 3-hydroxy-3methylglutaryl coenzyme A (HMG-CoA) reductase in rat (Wistar) liver and heart homogenates.TAAE and TAWE inhibited HMG-CoA reductase and lipid peroxidation. Both extracts decreased H2O2-mediated ROS generation in THP-1 cells by promoting the activities of catalase (CAT), glutathione peroxidase (GPx), and transcripts in THP-1 cells and HAECs. On the other hand, the response to TAWE differed based on the cell type and transcript type. Both extracts decreased the levels of common inflammatory marker proteins, including LPS-induced tumor necrosisfactor (TNF)-a, which is generated by THP-1 cells, and TNF-induced cell surface adhesion molecules on HAECs,In essence, triterpenoids are in charge of cardiovascular characteristics. Varghese et al. assessed the ability of T. LVP (LV [dP/dt] max and LV [dP/dt] min), cardiac contractility index (LV [dP/dt] max/LVP), and LVend-diastolic pressure have all been shown to decrease. Diabetic rats showed histological alterations in the heart and pancreas, as well as altered lipid profiles, oxidative stress, and elevated levels of endothelin 1 (ET-1), tumor necrosis factor-a (TNF-a), and interleukin 6 (IL-6). T.In diabetic rats, arjuna dramatically reduced myocardium damage and cardiac dysfunction. The antioxidative qualities of an ethanol extract of T. arjuna bark (TAEE) against salt have been studied by Sinha et al.Oxidative stress in the mouse heart caused by fluoride (NaF). All of the indicators pertaining to the heart's prooxidanteantioxidant condition were markedly changed by NaF poisoning. Furthermore, TAEE increased the intracellular antioxidant activity in the heart, according to the ferric reducing/antioxidant power assay. Ultimately, they came to the conclusion that TAEE, most likely through its antioxidant qualities, shields the hearts of mice from oxidative stress caused by NaF. Parveen et al evaluated the protective impact of T.the effects of arjuna bark extract on baroreflex and left ventricular (LV) function in chronic heart failure, as well as to clarify any potential molecular hints about its cardioprotective properties. Rats showed reduced baroreflex sensitivity, cardiac dysfunction, hypertrophy, and LV remodeling 15 days after being given isoproterenol. Baroreflex sensitivity and heart functions were enhanced by both preventative and therapeutic T. arjuna treatment. By preserving natural antioxidant enzyme activities and preventing lipid peroxidation and cytokine levels, T. arjuna may have a positive impact on LV functioning, myocardial remodeling, and autonomic regulation in chronic heart failure. T was extracted using ethanol, diethyl ether, and ethylacetate. In Poloxamer (PX)-407-induced hyperlipidemic albino Wistar rats, arjuna demonstrated hypolipidemic and antioxidant benefits at two distinct dose levels of 175 and 350 mg/kg body weight. assessed how T. arjuna bark extract affected oxidative stress and cardiac fibrosis brought on by long-term badrenoceptor activation. because certain cardiac conditions, including hypertrophiccardiomyopathy,hypertensive heart disease, and cardiac failure, are accompanied by myocardial fibrosis and oxidative stressT. water-based extract. Arjuna bark at 63, 125, and 250 mg/kg given orally was investigated for its antifibrotic and antioxidant properties in rats given the selective b-adrenoceptor agonist isoprenaline for 28 days. The bark

extract from T. arjuna prevented fibrosis and dramatically decreased the rise in oxidative stress and decrease in endogenous antioxidant levels caused by isoprenaline. In their study, Gauthaman et al. discovered that oral administration of T. arjuna to rabbits for 12 weeks induced heat shock protein72 (HSP72) and raised the levels of antioxidants in the heart, such as glutathione (GSH), catalase (CAT), and superoxide dismutase (SOD).In rabbit hearts treated with T. arjuna, oxidative stress, cardiac tissue damage, and hemodynamic consequences caused by in vivo ischemic-reperfusion injury were avoided. Protein oxidation, free radical scavenging, and DNA protection were assessed in an alcoholic extract of T. arjuna bark and its derivatives.According to the pBR 322 DNA and SCGE experiment, ethanolic extract of T. arjuna bark (TAA) and its fractions, such as dichloromethane (TAD), ethyl acetate (TAE), butanol (TAB), and water (TAW), have strong antioxidant activity and the capacity to stop protein oxidation and protect DNA from damage. Phenolic/flavonoid chemicals may support the strong antioxidant activity and DNA protection capabilities of T. arjuna bark extracts. The total phenolic/flavonoid content, in vitro DNA damaging activity, and free radical scavenging activity were also found to be significantly correlated. The aqueous extract of T's physicochemical characteristics and inotropic impact.Oberoi et al. examined the effects of arjuna bark (TAAqE) on adult rat ventricular myocytes in contrast to extracts made successively using organic extracts. They discovered that TAAqE infusions enhanced caffeine-sensitivity, accelerated myocyte relaxation, and exhibited positive inotropy.concentration-dependently caused contraction. Because of its ability to improve SR function and reduce the risk of arrhythmias, TAAqE produces a cardiotonic effect that is both safe and promising for both treating chronic heart disease and maintaining a healthy heart. Mandal et al. looked into the methanolic extract of T's antibacterial and antioxidant qualities.Barking arjuna. The DPPH free radical scavenging assay revealed a decrease in the absorption of DPPH radicals, indicating a potential antioxidant activity and a stronger inhibition against Gram negative bacteria than Gram positive bacteria. Methanol extract from T. arjuna bark shown both physiological and therapeutic effects.arjuna leaves and bark were tested for their antimicrobial activity against ear infection-causing pathogens, including Staphylococcus aureus, Acinetobacter sp., Proteus mirabilis, Escherichia coli, Pseudomonas aeruginosa, and Candida albicans. The best organic solvent against S was determined to be acetonic leaf extract. With the exception of P. aeruginosa, all studied Gram-negative bacteria were nearly equally inhibited by organic bark extract. The bark of T. arjuna showed good efficacy against S. aureus in an aqueous extract. arjuna methanolic extract (100–50 mg/kg body weight) on rats' stomach ulcers caused by diclofenac sodium (80 mg/kg bodyweight in water, orally). Measurements of the volume of gastric juice, pH, free and total acidity, pepsin concentration, acid output in gastric juice, levels of lipid peroxide (LPO), reduced glutathione (GSH), non-protein sulfhydryls (NP-SH), and the activities of enzymatic antioxidants—superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), glutathione-Stransferase (GST), and myeloperoxidase (MPO) in the gastric mucosa—were used to evaluate the gastroprotective effect of Arjuna T. DNA, protein-bound carbohydrate complexes (hexose, hexosamine, sialic acid, and fucose), and RNA levels in the stomach mucosa and stomach juice were assessed.The stomach tissues were employed for both the histological analysis and the measurement of adherent mucus content. arjuna (DIC þ TA) showed a substantial decrease in lesion index. While the volume of gastric juice, free and total acidity, pepsin concentration, acid output, LPO levels, and MPO activities significantly decreased in DIC þ TA rats compared to DIC rats, there was a significant increase in pH, NP-SH, GSH, enzymatic antioxidants, protein-bound carbohydrate complexes, adherent mucus content, and nucleic acids. The fact that T.Arjuna's ability to scavenge free radicals may make it a gastroprotective agent. [61]

CLINICAL STUDIES:

Numerous clinical investigations on a range of cardiovascular disorders have been conducted based on the findings of experimental research and, more significantly, because of its application in the Indian traditional medical system. [54]

Ischemic Heart Disease:

For three months, 15 stable and five unstable angina cases were used to study the effects of T. arjuna's dinghy greasepaint on angina frequency, blood pressure, body mass indicator, blood sugar, cholesterol, and HDL-cholesterol. In patients with stable angina, there was a 50% decrease in angina episodes. However, there was no discernible decrease in angina frequency in patients with unstable angina. Other medications were also required in some circumstances.such as nitroglycerine, beta-blockers, and diltiazem. In cases of stable angina, there was a slight improvement in left ventricular ejection bit, a decrease in systolic blood pressure and body mass indicator to a meaningful position, and a borderline increase in HDL-cholesterol. [54] Neither liver nor order functions had any harmful items. The study's authors came to the conclusion that in patients with stable angina pectoris, T. arjuna monotherapy would be reasonably successful. In a different double-eyeless, randomized crossover study, 48 male patients with consistent stable angina who had evidence of ischemia on regular tests were given either 500 mg of T. arjuna eight hours a day, 40 mg of isosorbide mononitrate per day, or a matching placebo for a week.The frequency of angina and the requirement for isosorbide dinitrate in the instances entering T. arjuna were significantly reduced. Over the course of 12 weeks, a personal herbal preparation that largely contained T. arjuna in 10 instances of stable angina considerably decreased the incidence of angina in an open, non-randomized experiment. It had no effect on renal or hepatic functioning. Stem dinghy greasepaint of T. arjuna (500 mg 8 hourly for 1 month) significantly improved diastolic dysfunction and decreased ischemic mitral regurgitation in instances of recent myocardial infarction in a double eyeless randomized placebo controlled research. arjuna in acute MI. According to all of these tests, the factory's antiischemic products can be utilized in conjunction with contemporary medications. [61]

Heart Failure:

Treatment of heart failure in ultramodern drug is far from satisfactory. Until lately, when some beta-blockers(sculpt dilol) and ACE- impediments were set up useful, there was har dly any medicine which targeted the introductory pathphysiology of the complaint. Indeed these medicines are inadequately permitted in numerous heart failure cases. thus, utmost medicines used in heart failure cause sympotomatic relief without important effect on the overall morbidity and mortality. In fact, the two-century old digoxin is no longer indicated in these cases. In this environment, the use of T. arjuna might be veritably promising. An hydroalcoholic excerpt of T. arjuna(500 mg q8h) de monstrated some salutary goods in 12 cases of severe refractory heart failure(NYHA class IV).(22) The study was divided into two ‘ phases’, in ‘ phase I’ the excerpt was admin istered to cases in a double eyelesscross-over design as an adjuvant to maximally tolerable conventional remedy for 2 weeks with a 2 week medicine/ placebo free period during cross over. T. arjuna, compared to placebo, caused enhancement in symptoms and signs of heart failure, enhancement in NY HA Class(Class III vs. Class IV) and increase in left ventri cular ejection fragments(35.33 ± 7.85 vs. 30.24 ± 7.13; p< 0.005). latterly in an open design(‘ phase II’), askers of ‘ phase I’ actors continued to admit the same medication of T. Arjuna in the same cure in addition to diuretic, vasodilator and digitalis for 20- 28 months(mean 24 months). Cases showed continued enhancement in symptoms, signs, trouble forbearance, NYHA Class and in quality of life. Although, the study has certain crunches, it's the only study which reported salutary goods of T. arjuna in heart failure cases. This intriguing finding has generated a need for larger randomized placebo controlled trials in this condition.[54]

Hyperlipidemia:

In a randomised placebo- controlled trial, 105 cases with coronary heart complaint entered pulverized T. arjuna dinghy- greasepaint(500 mg daily) for 30 days.[35] All cases followed American Heart Association Step II salutary advice and were n't specified any other lipid lowering medicines. There was a significant drop in total cholesterol and LDL cholesterol in the T. arjuna treated cases.[58]

Fig No.1: Terminalia Arjuna plant and bark[58]

Anticancer activity:

demonstrating the accumulation of various cancerous growths to treat Terminalia Arjuna separately. Terminalia Arjuna natural concentrates have been shown to enhance the increased level of life. [15] In HepG2 cells, Arjuna separate actuating DNA damage showed that
Terminalia Arjuna remove stimulates the production of ROS in HepG2 cells, which in turn
triggers apoptosis. [56]

Antidiabetic activity:

Terminalia Arjuna extracts have the ability to affect diabetics. In the logical analysis, two substances (glucose-6-phosphatase, fructose-1, 6-diphosphatase) were significantly reduced in the liver and kidney of diabetic animals treated with Terminalia Arjuna extracts. When phosphofructokinase and glucokinase, two important gluconeogenic enzymes, are suppressed, they can increase insulin release. By valuing the maximum use of glucose, which can aid in renal glycolysis, repairing the damaged liver, and reducing its gluconeogenic age, Terminalia arjun bark has revealed an antidiabetic effect similar to that of insulin.The presence of tannin, saponin, flavonoids, and other constituents in the bark may be responsible for this activity due to their constituents' potential to act as crucial components in enhancing the effects of gluconeogenic and glycolytic chemicals. have investigated the use of arjunolic acid as a preventative medium against streptozotocin (STZ) to treat diabetes in Swiss albino rat pancreatic tissue. When STZ is administered to laboratory animals at a dose of 65 mg/kg body weight and injected into the tail vein, the pancreas produces more reactive nitrogen species (RNS) and ROS. These reactive intermediates' formation reduces the intracellular antioxidant defense, increase serum glucose, TNF-α, protein carbonylation, and lipid peroxidation levels. [60]

Antiacne Activity:

Flavonoid (FF-I to III) and tannin division (TF-I to III)-containing skin arrangement-made cream of Terminalia Arjuna was developed, and its antibacterial activity against Propionibacterium acnes and Staphylococcus epidermidis was examined. Similar to standard encouraged effective natural readiness, the creation of FF-III (cream containing 2% flavonoid division) has demonstrated the most extreme antibacterial movement against P. acnes (zones of hindrance >17 mm) and S. epidermidis (zones of hindrance >20 mm) compared to other creations. Skin breakout cream's natural enemy is non-toxic, safe, and effective. Treating patient consistency with locally grown Terminalia Arjuna separates would be highly beneficial. [61]

Anthelmintic activity:

Terminalia Arjuna bark rough methanolic concentrates had anthelmintic activity against sheep's mixed gastrointestinal trichostrongylid nematodes in both in vitro (eggs, hatchlings, and adults of Haemonchus contortus) and in vivo studies. The bark of Terminalia Arjuna has an anthelmintic effect and may be primarily attributed to its tannin content, which is linked to the development of free proteins in the cylinders for larval sustenance and reduces supplement movement, resulting in decreased gastrointestinal digestion in larvae by directly preventing oxidative phosphorylation, which in turn causes larval passing. [61]

Antiasthmatic Activity:
Terminalia Arjuna bark rough methanolic concentrates had anthelmintic activity against sheep's mixed gastrointestinal trichostrongylid nematodes in both in vitro (eggs, hatchlings, and adults of Haemonchus contortus) and in vivo studies. The bark of Terminalia Arjuna has an anthelmintic effect and may be primarily attributed to its tannin content, which is linked to the development of free proteins in the cylinders for larval sustenance and reduces supplement movement, resulting in decreased gastrointestinal digestion in larvae by directly preventing oxidative phosphorylation, which in turn causes larval passing. [61]

Anti-inflammatory:
In both in vitro (eggs, hatchlings, and adults of Haemonchus contortus) and in vivo investigations, Terminalia Arjuna bark rough methanolic concentrates shown anthelmintic action against sheep's mixed gastrointestinal trichostrongylid nematodes. Because of its tannin content, which is linked to the development of free proteins in the cylinders for larval sustenance and reduces supplement movement, Terminalia Arjuna bark has an anthelmintic effect. This reduces gastrointestinal digestion in larvae by directly preventing oxidative phosphorylation, which in turn causes larval passing. [61]

Effect on aortic prostaglandins:
Rough methanolic concentrations of Terminalia Arjuna bark have demonstrated anthelmintic activity against sheep's mixed gastrointestinal trichostrongylid nematodes in both in vitro (eggs, hatchlings, and adults of Haemonchus contortus) and in vivo studies. The bark of Terminalia Arjuna has an anthelmintic impact because to its tannin concentration, which is associated with the synthesis of free proteins in the cylinders for larval feeding and decreases supplement mobility. This directly inhibits oxidative phosphorylation, which leads to larval passage and lessens gastrointestinal digestion in larvae. [61]

CONLUSION:
Rough methanolic concentrations of Terminalia Arjuna bark have demonstrated anthelmintic activity against sheep's mixed gastrointestinal trichostrongylid nematodes in both in vitro (eggs, hatchlings, and adults of Haemonchus contortus) and in vivo studies. The bark of Terminalia Arjuna has an anthelmintic impact because to its tannin concentration, which is associated with the synthesis of free proteins in the cylinders for larval feeding and decreases supplement mobility. This directly inhibits oxidative phosphorylation, which leads to larval passage and lessens gastrointestinal digestion in larvae. [61]

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