GOKHRU *(TRIBULUS TERRESTRIS* L.): A TRADITIONALLY IMPORTANT WILD MEDICINAL HERB OF WASTE LANDS

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REFERENCES

Adaikan, P.G.; Gauthaman, K.; Prasad, R.N.V. and Ng S.C. (2000). Proerectile pharmacological effects of *Tribulus terrestris* extract on the rabbit corpus cavernosum. *Annals Academy of Medicine Singapore* **29**(1): 22-26.

Adimoelja, A.(2000). Phytochemicals and the breakthrough of traditional herbs in the management of sexual dysfunctions. *International Journal of Andrology* **23**(Supplement 2): 82-84.

Ali, A.M.; Wahbi, S.; Twaij, H. and Al, B.A. (2003). *Tribulus terrestris*: Preliminary study of its diuretic and contractile effects and comparison with Zea mays. *Journal-of-Ethno pharmacology* **85**(2-3): 257-260.

Ali, G.M.; Srivastava, M.H. and Iqbal, P.S. (1997). Micropropagation of *Tribulus terrestris* L., an important medicinal plant. *Journal of Plant-Biology* **40**(3): 202-205.

Ali, N.A.A.; Juelich, W.D.; Kusnick, C. and Lindequist, U. (2001). Screening of Yemeni medicinal plants for antibacterial and cytotoxic activities. *Journal of Ethno pharmacology* **74**(2): 173-179.

Anand, R.; Patnaik, G.K.; Kulshreshtha, D.K. and Dhawan, B.N. (1994). Activity of certain fractions of *Tribulus terrestris* fruits against experimentally induced urolithiasis in rats. *Indian-Journal-of-Experimental-Biology*, **32**(8): 548-552.

Athar, M. and Mahmood, A. (1985). Nodulation and nitrogen fixation by *Tribulus terrestris* under natural conditions. *Pakistan Journal of Agricultural Research*, **6**(2): 101-106.

Balyaeva, N.S. (1980). Interrelation between male gametes and cells of female gametophytes in angiosperms double fecundation hypothesis. Izvestiya Akademii Nauk Turkmenskoi SSR Seriya Biologicheskikh Nauk **5**: 43-51.

Barker, R.M. (1998). A trial key and notes on *Tribulus terrestris* (Zygophyllaceae) in Australia, including one new species and validation of *Tribulus suberosus*. *Nuytsia*, **12**(1): 9-35.

Bhansali, A.K. (1980). Cytological analysis of morpho-logical variants of *Tribulus terrestris*. *Indian Forester*, **106**(10): 734-737.

Boydston, R.A. (1990). Times of emergence and seed production of long spine sandbur cenchrus longspinus and puncture vine (*Tribulus terrestris*). *Weed science* **38**(1): 16-21.

Chakraborty, B. and Neogi, N.C. (1978). Pharma-cological properties of *Tribulus terrestris* Linn. *Indian J Pharm Sci*, **40**: 50-2.

Conrad, J.; Dinchev, D.; Klaiber, I.; Mika, S. And Kostova, Kraus W. (2004). A novel furostanol saponin from *Tribulus terrestris* of Bulgarian origin. *Fitoterapia* **75**(2): 117-122.

De, C.E.; Fuzzati, N.; Lovati, M. and Mercalli, E. (2003). Furostanol saponins from *Tribulus terrestris*. *Fitoterapia* **74**(6): 583-591.

Deepak, M.; Dipankar, G.; Prashanth, D.; Asha, M.K.; Amit, A, and Venkataraman, B.V. (2002). Tribulosin and beta-sitosterol-D-glucoside, the anthelmintic principles of *Tribulus terrestris*. *Phytomedicine* (Jena) **9**(8): 753-756.

Duhan, A. and Chauhan, B.M. and Punia, D. (1992). Nutritional value of some non-conventional plant foods of India. *Plant Foods for Human Nutrition* **42**(3): 193-200.

E.L. Gareeb, R.M. (1991). Suppression of annuals by *Tribulus terrestris* in an abandoned field in the

sandy desert of Kuwait. *Journal of Vegetation Science*. **2**(2): 147-154 .

Erhun, W.O. and Sofowora, A. (1986). Callus induction and detection of metabolites in *Tribulus terrestris*. *Journal of Plant Physiology* **123**(2): 181-186.

Ernst, W.H.O. and Tolsma, D. J. (1988). Dormancy and germination of semi-arid annual plant species *Tragus berteronianus* and *Tribulus terrestris*. *Flora* **181**(3-4): 243-251.

Fang, S.; Hao, C.; Sun, W. Liu, Z. and Liu S. (1998). Rapid analysis of steroidal saponin mixture using electrospray ionization mass spectrometry combined with sequential tandem mass spectrometry. Rapid Communications in Mass Spectrometry **12**(10): 589-594.

Fotedar, J.L. and Roy, S.K. (1969). Tetraploid *Tribulus* Linn. *Sci. Cult,* **35:** 25-28.

Fukuda, Y. (1982). Morphological and anatomical studies of *Tribulus terrestris* 2 vascular course through cotyledonary and foliar nodes. *Botanical Magazine Tokyo,* **95**: 183-194.

Ganzera, M.; Bedir, E. and Khan, I. A. (2001). Determination of steroidal saponins in *Tribulus terrestris* by reversed-phase high-performance liquid chromatography and evaporative light scattering detection. *Journal of Pharmaceutical Sciences,* **90**(11): 1752-1758.

Gauthaman, K. and Adaikan, P.G. (2005). Effect of *Tribulus terrestris* on nicotinamide adenine dinucleotide phosphate-diaphorase activity and androgen receptors in rat brain. *Journal-of-Ethno pharmacology*, **96**(1-2): 127-132.

Gauthaman, K.; Adaikan, P.G. and Prasad, R.N.V. (2002). Aphrodisiac properties of *Tribulus terrestris* extract (Protodioscin) in normal and castrated rats. *Life-Sciences*, **71**(12): 1385-1396.

Heiser, C.B. and Whitaker, T.W. (1948). Chromosome number and polyploidy and growth habit in Californian weeds. *Am. J. Bot.*, **35**: 179-186.

Huang, X.L.; Zhang, Y.S. and Liang, Z.Y. (1991). Studies on water soluble polysaccharides isolated from *Tribulus terrestris* L. purification and preliminary structural determination of heteropolysaccharides. Yaoxue-Xuebao, **26**(8): 578-583.

Humphry, C.M.; Clegg, M.S.; Keen, C.L. and Grivetti, L.E. (1993). Food diversity and drought survival: The Hausa example. *International Journal of Food Sciences and Nutrition*, **44**(1): 1-16.

Jain,V.K. and Gupta, P. (1981). Changes in gamma-methylene glutamic acid, gamma-methylene glutamine, other amino acids and amides during fruit growth of *Tribulus terrestris*. *Giornale Botanico Italiano,* **115**(2-3): 89-94.

Kemertelidze, E.P.; Pkhidze, T.A.; Kachukhashvili, T.N. Umikashvili, R.S.; Turova, A.D. and Sokolova, L.N. (1982). The new antisclerotic drug tribusponin. Khimiko-Farmatsevticheskii Zhurnal, **16**(1): 119-122.

Kostova, I.; Dinchev, D.; Rentsch, G.H.; Dimitrov, V. And Ivanova, A. (2002). Two new sulfated furostanol saponins from *Tribulus terrestris*. Zeitschrift fuer Naturforschung Section C *Journal of Biosciences*, **57**(1-2): 33-38.

Koumanov, F.; Bozajieva, E.; Andreeva, M.; Platonva, E. and Ankov, V. (1982). Clinical trial of Tribestan. *Exper. Med.*, **1:** 2-4.

Kumari, K.S. and Lyer, G.Y.N. (1967). Preliminary studies on the diuretic effect of Hygrophila spinosa and *Tribulus terrestris*. *Ind. J. Med. Res.*, **55**(7): 714-716.

Li JX, Shi Q.; Xiong, Q.B.; Prasain, J.K.; Tezuka, Y.; Hareyama, T.; Wang, Z.T.; Tanaka, K.; Namba, T.; Kadota, S.; Tribulusamide A and B, (1998). new hepatoprotective lignanamides from the fruits of *Tribulus terrestris*: Indications of cytoprotective activity in murine hepatocyte culture. *Planta Medica,* **64**(7): 628-631.

Liu, Q.; Chen, Y.; Wang, J.; Chen, X. and Han, Y. (1995). A study of the protective effects of *Tribulus terrestris* L., polysaccharide on genetic damage. *Zhongguo Zhongyao Zazhi* **20**(7): 427-429.

Louveaux, A.; Jay, M. El, H.O.T.M. and Roux G. (1998). Variability in flavonoid compounds of four *Tribulus species*: Does it play a role in their identification by desert locust Schistocerca gregaria? *Journal of Chemical Ecology* **24**(9): 1465-1481.

Mahato, S.B.; Sahu, N.P.; Ganguly, A.N.; Miyahara, K. and Kawasaki,T. (1981). Steroidal glycosides

of *Tribulus terrestris. Journal of the Chemical Society Perkin Transactions*-I, **(9)**: 2405-2410.

Main, A. (1986). A contribution of biology of Houbara some studies of Gizzard contents from 1983-84 wintering population in the western Baluchistan *Pakistan. Pakistan Journal of Zoology,* **18**(4): 363-370.

Malik, C.P. (1966b). Corrected basic chromosome number and intraspecific polyploidy in *Tribulus terrestris* Linn. *Chromo. Inf. Serv.*, **7**: 7-8.

Mesicek, J. and Sojak, J. (1995). Chromosome numbers of Mongolian angiosperms: II. Folia Geobotanica et *Phytotaxonomica,* **30**(4): 445-453.

Moeloek, N.; Pangkhila, W.; Tanojo, T.D. and Adimoelja, A. (1994). Trial on *Tribulus terrestris* L. on idiopathic oligo-astheno-terato-zoospermia. Presented at the 6th National Congress Indonesian Society of Andrology and 3rd International Symposium on 'New Perspectives of Andrology in Human Reproduction'. Manado, Indonesia, September, 1994.

Mohan, J.S.S.; Kumar, V. Vijaya, Aparna V. and Vaidya, R.P. (2000). Somatic embryogenesis and plant regeneration in *Tribulus terrestris* L. *Phytomorphology,* **50**(3-4): 307-311.

Morrison, S.M. and Scott, J.K. (1996). Variation in populations of *Tribulus terrestris* (Zygo-phyllaceae): Burr morphology. *Australian Journal of Botany,* **44**(2): 175-190.

Morrison, S.M. and Scott, J.K. (1996). Variation in populations of *Tribulus terrestris* (Zygo-phyllaceae): 2. Chromosome numbers. *Australian Journal of Botany,* **44**(2): 191-199.

Morrison, S.M. and Scott, J.K. (1996). Variation of populations of *Tribulus terrestris* (Zygo-phyllaceae): 3. Isozyme analysis. *Australian Journal of Botany,* **44**(2): 201-212.

Mossa, J.S; Al, Y.M.A. and Al, M.I.A. (1983). Tari QM. Phytochemical and biological screening of Saudi medicinal plants 5. *Fitoterapia,* **54**(4): 147-152 .

Mossa, J.S.; Al, Y.M.A. Al, M.I.A. and Tari, Q.M. (1983). Phytochemical and biological screening of Saudi medicinal plants 5. *Fitoterapia* **54**(4): 147-152.

Nag, T.N.; Grover, S.; Tiwari, A.; Surendrajit, Shekhawat, S.S. and Harsh, M.L. (1986). Free endogenous ascorbic acid from Zygophyllous plants growing in arid zone of Rajasthan India. *Indian Journal of Botany,* **9**(2): 112-113.

Pilipenko, V.V. and Sukhodub, L.F. (2003). Mass-spectrometric investigation of composition and structure of steroid glycosides from *Tribulus terrestris* L. and *Agave sisalana* L. Biopolimery I Kletka, **19**(5): 432-435.

Porter, D.M. (1968). The basic chromosome number in *Tribulus* (Zygophyllaceae). *Wasmann. J. Biol.*, **26**: 5-6.

Protich, M.; Tsvetkov, D.; Nalbaski. B.; Stanislavov, R. and Katsarova, M. (1983). Clinical trial of the preparation of Tribestan in infertile men. *Obstet Gynaecol Sofia,* **22**: 326-8.

Rajashekhargouda, R.; Gopalan, M.; Jayaraj, S. and Natarajan, N. (1997). Field performance of plant extracts on mulberry silkworm, *Bombyx mori* L. *Entomon,* **22**(3-4): 235-238.

Rall, M. and Fairall, N. (1993). Diets and food preferences of two South African tortoises *Geochelone pardalis* and *Psammobates oculifer*. *South African Journal of Wildlife Research* **23**(3): 63-70.

Rashid, A. (1974). Chromosome numbers of some Mediterranean plants. *Bangladesh J. Bot.,* **3**: 75-82.

Reddi, C.S.; Reddi, E.U.B. and Reddi, N.S. (1981). Breeding structure and pollination ecology of *Tribulus terrestris.* Proceedings of the Indian National Science Academy Part B *Biological Sciences,* **47**(2): 185-193.

Ren, Y.J.; Chen, H.S.; Yang, G.J. and Zhu, H. (1994) Isolation and identification of a new derivative of cinnamic amide from *Tribulus terrestris*. Yaoxue-Xuebao, **29**(3): 204-206.

Sajid, T.M.; Rashid, S. and Saeed, S.A. (1991). Inhibition of adrenaline- induced aggregation of human platelets by Pakistani medicinal plants. *Pakistan Journal of Pharmaceutical Sciences,* **4** (2): 145-152.

Saleh, N.A.M.; Ahmad, A.A. and Abdullah, M.F. (1982). Flavonoid glycosides of *Tribulus*

pentandrus and *Tribulus terrestris*. *Phytochemistry* (Oxford) **21**(8): 1995-2000.

Sane, R.T.; Sasikumar, M.; Deshpande. A.Y.; Menezes, A.A. and Gundi, G. (2004). Quantitation of protodioscin in *Tribulus terrestris* L. fruit powder by reversed-phase high-performance thin-layer chromatography. *Journal of Planar-Chromatography-Modern*-TLC **17**(5): 379-382.

Sangeeta, D.; Sidhu, H.; Thind, S.K. and Nath, R. (1994). Effect of *Tribulus terrestris* on oxalate metabolism in rats. *Journal of Ethno pharmacology* **44**(2): 61-66.

Seth, S.D. and Jagadeesh, G. (1976). Cardiac action of *Tribulus terrestris. Indian J. Med. Res.,* **64:** 1821-1825.

Sharifi, A.M.; Darabi, R. and Akbarloo, N. (2003). Study of antihypertensive mechanism of *Tribulus terrestris* in 2K1C hypertensive rats: Role of tissue ACE activity. *Life Sciences*, **73**(23): 2963-2971.

Singh, R.G.; Singh, R.P.; Usha, K.P.; Shukla, K.P. and Singh P. (1991). Experimental evaluation of diuretic action of herbal drug (*Tribulus terrestris* Linn.) on albino rats. *J. Res. Edu. Ind. Med.*, **10**(1): 19-21.

Singh, R.P.; Singh, R.G.; Usha, Shukla, K.P. and Udupa, K.N. (1990). Biochemical and histopathological effects of *Boerhaavia diffusa* (PUNARNAVA) and *Tribulus terrestris* (GOKSHURA) induced diuretics in rats. *Alternative Medicine*, **3**(3): 165-172.

Singh, R.P.; Tomar, S.S.; Devakumar, C.; Goswami, B.K. and Saxena, D.B. (1991). Nematicidal efficacy of some essential oils against meloidogyne-Incognita. *Indian Perfumer*, **35**(1): 35-37.

Stanislavov, R. and Niklova, V. (1999). *Tribulus terrestris* and human male infertility: immunological aspects. Presented at the European Meeting of Immunology and Reproduction, Rome, Italy, 28-29 October 1999.

Sun, B.; Qu, W.J.; Zhang, X.L.; Yang, H.; Zhuang, X.Y. and Zhang, P. (2004) Investigation on inhibitory and apoptosis-inducing effects of saponins from *Tribulus terrestris* on hepatoma cell line BEL-7402. Zhongguo Zhongyao Zazhi **29**(7): 681-684.

Surender, J.I.T.; Shekhawat, S.; Grover, S. and Nag, T.N. (1986). Screening of some plants of zygophyllaceae from their antimicrobial activity. *Acta Botanica Indica*, **14**(1): 45-47.

Twaij, H. A.A.; Mahmoud, S. N. and Khalid, R. M. (1987). Molluscicidal evaluation of some Iraqi medicinal plants. *Journal of Biological Sciences Research*, **19**(SUPPL): 773-776.

Twaij, H.A.A.; Mahmoud, S.N. and Khalid, R.M. (1989). Screening of some Iraqi medicinal plants for their molluscicidal activities. *Fitoterapia*, **60**(3): 267-268.

Wang, B.; Ma, L. and Liu, T. (1990). 406 cases of angina pectoris in coronary heart disease treated with saponin of *Tribulus terrestris. Chung His Chieh Ho Tsa Chih*, **10**: 85-7.

Wang, Y.; Ohtani, K.; Kasai, R. and Yamasaki, K. (1997). Steroidal saponins from fruits of *Tribulus terrestris*. *Phytochemistry*-(Oxford), **45**(4): 811-817

Whitson, T.D. Burrill, L.C.; Dewey, S.A.; Cudney, D.W.; Nelson, B.E.; Lee, R.D. and Parker, R. (1996). Puncturevine, *Weeds of the west*,127-128.

Wilkins, A.L.; Miles, C.O.; De, K.W.T.; Erasmus, G.L.; Basson, A.T. and Kellerman, T.S. (1996). Photosensitivity in South Africa. IX. Structure elucidation of a beta-glucosidase-treated saponin from *Tribulus terrestris*, and the identification of saponin chemo types of South African T. terrestris. *Onderstepoort Journal of Veterinary Research*, **63**(4): 327-334.

Wu, G.; Jiang, S.; Jiang, F.; Zhu, D.; Wu, H. and Jiang, S. (1996). Steroidal glycosides from *Tribulus terrestris*. *Phytochemistry*-(Oxford) **42** (6): 1677-1681.

Wu, T.S.; Shi, L. S. and Kuo, S. (1999). Alkaloids and other constituents from *Tribulus terrestris*. *Phytochemistry*-(Oxford), **50**(8): 1411-1415.

Xu, Y.J. Xie, S.X.; Zhao, H.F.; Han, D, Xu, T.H. and Xu, D.M. (2001). Studies on the chemical constituents from *Tribulus terrestris*. Yaoxue-Xuebao, **36**(10): 750-753.

Xu,Y.X.; Chen, H.S.; Liang, H.Q.;, Gu Z.B.; Liu, W.Y.; Leung, W,N. and Li, T.J. (2000). Three new saponins from *Tribulus terrestris. Planta Medica*, **66**(6): 545-550.

Xu, Y.X.; Chen, H.S.; Liu, W.Y.; Gu, Z.B. and Liang, H.Q. (1998). Two sapogenins from *Tribulus terrestris*. *Phytochemistry*-(Oxford), **49**(1): 199-201.

Yan, W.; Ohtani, K.; Kasai, R. and Yamasaki, K. (1996). Steroidal saponins from fruits of *Tribulus terrestris*. *Phytochemistry*-(Oxford), **42**(5): 1417-1422.

Zarkova, S. (1984). Steroid saponins of *Tribulus terrestris* having a stimulant effect on the sexual functions. *Revista-Portuguesa-de-Ciencias-Veterinarias*, 79 (470): 117-126.