

RUTIN (NATURAL BIOFLAVONOID): TRADITIONAL AND MEDICINAL USES

Kamal Kishore

Department of Pharmacy, M.J.P. Rohilkhand University,
Bareilly-243006 (U.P.) INDIA

E-mail: kamalbareilly@yahoo.co.in

Summary

Rutin is a natural polyphenolic bioflavonoid, widely distributed in the plant kingdom. It is commercially obtained from buckwheat (*Fagopyrum esculentum* and *Fagopyrum tataricum*) (Polygonaceae) in India. It is a powerful antioxidant that fights free radicals, which are said to be responsible for as much as 90% of all human diseases. The deficiency of rutin in diet has been linked with abnormal capillary leakiness, pain in extremities, body aches, weakness and night leg cramps. Rutin may be useful in edema, excess swelling in legs due to fluid retention, chronic venous insufficiency, venous hypertension, paresthesia, hemorrhoids, micro-angiopathy, neuropathy, atherosclerosis, asthma, leukemia, learning and memory impairment and numerous other pathophysiological conditions. This article provides general as well as recent information regarding the rutin that may be useful for it better understanding by users and health care professionals.

Key words: Bioflavonoid, Polyphenol, Antioxidant, Quercetin, Vitamin-P

Introduction

Rutin, a natural bioflavonoid, polyphenol, water soluble antioxidant that is widely distributed in the plant kingdom. It is often found in nuts, fruits, pulp, and rinds of orange, pine bark, garlic, grapes (1), lemon, lime, peaches, apicots, apples, blue and green berries and in vegetables such as green and yellow peppers, onions, broccoli, parsley, bee propolis, green tea, black tea, whole grains etc. rutin is a solid, pale yellow substance, molecular formula is $C_{27}H_{30}O_{16}$, and molecular weight is 610.53 Daltons. It is a glycoside of quercetin and contains at 3-position the sugar rutinose composed of glucose and rhamnose. Rutin is commercially obtained from buckwheat (*Fagopyrum tataricum* and *Fagopyrum esculentum* moench, the flour of which is used to make pancakes) (Polygonaceae) in India and from *Eucalyptus macrorryneha* (Myrtaceae) (2) in Australia and flowers of *Sophora Japonica*, commonly known as Japanese pagoda tree (Leguminosae) in Japan. It is also present in leaves of *Ruta graveolens* (3) as a non-bitter tasting flavonoid glycoside or rutoside. It scavenges superoxide radicals, inhibit lipid peroxidation, involved in generation of reactive oxygen species, modulate the respiratory burst of neutrophils and improve biological antioxidants.

Rutin together with other flavonoids and vitamin-C has vitamin-P like actions and essential for the processing of collagen, the intercellular cement of the body. It is especially helpful in preventing recurrent bleeding caused by weakened blood vessels. It is also effective in the treatment of hemorrhoids (4,5), varicose veins, blood vessels and rigidity, chilblains, high blood pressure (6) and poor blood circulation. Furthermore, rutin also possesses antioxidant, anti-inflammatory, anticarcinogenic, antithrombotic, cytoprotective and vasoprotective properties.

Uses of Rutin

Veins and blood disorders

In clinical trials, rutin has demonstrated its activity by improving venous tone, vein elasticity, body temperature and was effective in controlling chronic venous hypertension (6), hemorrhoids (4,5), micro-angiopathy (7) and neuropathy. It is also useful in recurrent bleeding, bruises, infant leukemia (8), lymphedema of upper limbs (9), internal hemorrhoids of pregnancy (10). Rutin is an important nutrient due to its ability to strengthen and modulate the permeability of the walls of blood vessels including capillaries. It also helps in ruptures in the capillaries and connective tissues. Rutin and other bioflavonoids are widely used for the treatment of chronic venous insufficiency.

Thrombosis

Rutin possess antithrombotic and platelet aggregation inhibition activities like others natural bioflavonoids (11) and effectively used in the treatment of superficial venous thrombosis. The activated anti-platelet cells adhering to vascular endothelium generate lipid peroxides and oxygen-free radicals which inhibit endothelial biosynthesis of prostacyclin and destroy endothelium-derived relaxing factor. Rutin and other flavonols are antithrombotic because they are selectively bound to mural platelets thrombi and owing to their free radical scavenging properties resuscitate biosynthesis and action of endothelial prostacyclin and endothelium derived relaxing factor. Thus, flavonols release the thrombolytic and vasoprotective endothelial mediators only in these vascular segments which are covered by a carpet of aggregating platelets (12). The flavonoids and flavonoid-glycosides of *Sophora Japonica*, a major source for commercial rutin inhibits the platelet aggregation (13).

Cardiac functions

High polyphenols intake from diet is associated with reduced risk for cardiovascular diseases such as atherosclerosis, cardiac arrhythmia and many others. Polyphenolic compounds reduce platelet aggregation (14). Rutin in combination with lovastatin lowering the cholesterol levels in an animal model (15). It is also reported that rutin and quercetin inhibit oxidation of HDL and LDL that may help in cure and prevention of atherosclerosis (16,17). Rutin partially reverse impairment of cardiac functions in streptozotacin induced diabetes in rats (18).

CNS and tardive dyskinesia

Tardive dyskinesia is a hyperkinetic motor disorder of the orofacial region, resulting from chronic neuroleptic treatment, which may cause oxidative damage in all most all regions of brain by raising free radical level in the body. Rutin in high dose is effective in haloperidol induced orofacial dyskinesia and associated behavioural, biochemical and neurochemical changes (19). Rutin is also effective in paresthesia, meniere,s syndrome and schizophrenia.

As antiradical

Bioflavonoids also include the important caechins of green tea and the polyphenoes of red wine. Recent studies shown that the bioflavonoids are powerful antioxidants that fight free radicals. Free radicals are said to be responsible for as much as 90% of all the human diseases. Free radicals also play a pathological role in aging and age related memory loss. Rutin, a reputed natural bioflavonoid, anti-oxidant (20,21) or free radical scavenger, found to improve learning and memory in normal and aged mice.

As contraceptive

Rutin is the active ingredient of Rue (*Ruta graveolens*), and historically Rue has been used as tea to induce miscarriage by thousands of women in latin America. The leaves were also eaten daily in salads as a contraceptive to prevent pregnancy. Rutin in a dose of 500mg per day prevent pregnancy after fertilizing intercourse and continue until the menstrual flow begins (22), rutin prolongs the action of the adrenaline and decreases capillary permeability in the uterine tissues, causes endometrium to become non-nutritive to the fertilitized egg. The egg does not implant and abortion occurs (23). Rutin may make one feel anoxious or fearful due to its effect of keeping adrenaline in the bloodstream. It may cause skin rashes, stomach ache, allergic reactions and diarrhea in overdoses.

Neurodegenerative amnesia

Flavonoids inhibit free radicals cytotoxicity and have potent role in the prevention of apoptosis and neurodegenerative disorders (24) associated with memory impairment (25). Rutin, is a bye product of the tobacco industry, or obtained from eucalyptus (2) and other plants. It has potent antioxidant properties, frequently used in capillary bleeding. Rutin and other bioflavonoids such as bacosides, ginkgolides (26), ginsenosides (27), melatonin (28) and vitamin E, significantly enhance learning and memory by preventing cell death (29,30).

Alcoholic amnesia

Alcohol (ethanol) is one of the most commonly used drugs around the world, produced by the fermentation of fruits, vegetables or grains. Like all other drugs it has profound effects on the body. It affects the brain and alters its normal functioning. This includes alteration in the effects of neurotransmitters, suppressing nerve signals, and in the death of its cells in long term. Alcohol acts as a depressant on the nervous system, which slows all major body functions. Prenatal alcohol exposure produces fetal alcoholic syndrome (FAS) (31,32,33), which manifested as organic disturbances, learning and memory impairment (34,35). Alcohol toxicity cause cell membrane destruction and cell damage that may be due to increased oxidative stress or generation of oxygen metabolites (O_2^-), hydrogen peroxide (H_2O_2) and hydroxyl radicals (OH^-). Chronic alcohol consumption in human cause neurodegeneration and cognitive dysfunction. Alcohol damage the entorhinal cortex, hippocampal formation, and loss of grey and white matter, hippocampal volume and shrinkage of hippocampal neurons and entorhinal cortex. Alcohol causes irreversible damage to memory and intellect. It destroys brain diencephalic and cortical neurons cells whether consumed in acute or chronic doses. Ethanol induced cell death very similar to apoptotic cell death like, positive staining during TUNEL assay of fragmented DNA, identical time of death as seen in apoptosis and cell death (36) stopped by caspase inhibitor. All these reports revealed that alcohol caused impairment of learning and memory might be due to higher oxidative stress or either by apoptotic cell suicide.

Rutin prevents apoptotic cell death (37,38) and found to improve cognition in prenatal alcoholically amnesic pups, using morris water maze test (39).

Miscellaneous uses

Rutin is effective as spasmolytic, cyclo-oxygenase and lipoxygenase inhibitor, retinopathy, positive inotropic, intensify the effect of vitamin-C in the body by preventing its oxidation. Rutin is also useful in brusing, spider veins, arthritis, hemmorahage, phlebitis, herpes, cataracts, bleeding gums, nose and clots. Standardized rutin extracts used in antioxidant products, multivitamin and mineral supplements and therapeutically useful in different pathophysiological conditions like allergies (40), aneurism, anti-aging, viral infections, bacterial infections, inflammation (41), asthma, atherosclerosis, harden bones and teeth, tumour, breast cancer, colon cancer (42) and cancer (41,43), capillary fragility (44), cellular regeneration, chronic venous insufficiency (45), circulatory disorders, diabetic complications (46), hay fever, hemorrhoids, immune system, leg vein health, menopausal symptoms such as hot flashes, heavy legs, nocturnal leg cramps, leg ulcers (47) neck pain, pain in lower extremities, pain from injuries in athletes (48), prevention of abnormal growth of mammary gland (49), skin conditions, renal complications, strokes, senility, osteoporosis, osteoarthritis, vascular disorders (50), wounds, oral herpes, low serum calcium, help in absorption of iron, make less susceptible to cold sores and also useful in radiation injury and atomic burns (3). It is reported that rutin is effective in deafness, gastric ulcer, Grave's disease, common cold (51), sepsis and trauma. Rutin has been shown to reduce edema (6) or excess swelling in the legs due to fluid retention (52).

Conclusion

Rutin is a bioflavonoid, polyphenol, powerful antioxidant that fights free radicals. It may be useful in edema, excess swelling in legs due to fluid retention, chronic venous insufficiency, venous hypertension, paresthesia, hemorrhoids, micro-angiopathy, neuropathy, atherosclerosis, asthma, leukemia, learning & memory impairment, and numerous other pathophysiological conditions. It is clear from the literature rutin may help in the treatment of numerous human diseases and may be used as a multipurpose drug. This article may be useful for it better understanding by users and health care professionals.

Acknowledgement

The authors express their heartfelt thanks to Dr. Ranjit Singh, Prof. & Head, School of Pharmaceutical Sciences, Shobhit University, NH-58, Modipuram, Meerut-250 110, (U.P.) India, for their technical support.

References

1. Ross SA, Ziska DS, Zhoa K. Variance of common flavonoids by brand of grapefruit juice. *Fitoterapia*. 2000; 71:154-161.
2. Devartohalamani AM. Eucalyptus macrorhyncha in the Nilgiri and Palani hills of south India – An important source for rutin. *Ind For* 1969; 95(7):437-474.
3. Shah CS, Qadry JS. A text book of Pharmacognosy, glycosides (6th ed.). B.S. Shah Prakashan, 1183, Pankore Naka, Ahmedabad-380001, India. 1989, 149-150.

4. Sumboonnonda K, Lertsithichai P. Clinical study of the Ginko biloba-Troxeerutin-Heptaminol Hce in the treatment of acute hemorrhoid attacks. *J Med Assoc Thai* 2004; 87(2):137-142.
5. Alonso-Coello P, Zhou Q, Martinez-Zapata MJ. Meta-analysis of flavonoids for the treatment of haemorrhoids. *Br J Surg* 2006; 93(8):909-1020.
6. Cesarone MR, Belcaro G, Pellegrini L. HR, 0-(beta-hydroxyethyl)-rutosides, in comparison with diosmin+hesperidin in chronic venous insufficiency and venous microangiopathy: an independent, prospective, comparative registry study. *Angiology* 2005; 56:1-8.
7. Incandela L, Cesarone MR, DeSanctis MT, Belcaro G, Dugall M, Acerbi G. Treatment of diabetic microangiopathy and edema with HR (Paroven, Venoruton; 0-(beta-hydroxyethyl)-rutosides): a prospective, placebo-controlled, randomized study. *J Cardiovasc Pharmacol Ther* 2002; (7 Suppl 1):S11-5.
8. Strick R, Strissel PL, Borgers S. Dietary bioflavonoids induce cleavage in the MLL gene and may contribute to infant leukemia. *Proc Natl Acad Sci* 2000; 97:4790-4795.
9. Clusan RV, Alliot F, Ghabboun S. Treatment of secondary lymphedema of the upper limb with CYCLO 3 FORT. *Lymphology* 1996; 29:29-35.
10. Buckshee K, Takkar D, Aggarwal N. Micronized flavonoid therapy in internal hemorrhoids of pregnancy. *Int J Gynaecol Obstet* 1997; 57:145-151.
11. Anton R, Beretz A. Flavonoids: antithrombotic agents or nutrients? *Bull Acad Natl Med* 1990; 174(6):709-714.
12. Grylewski RJ, Korbut R, Robak J, Swies J. On the mechanism of antithrombotic action of flavonoids. *Biochem Pharmacol* 1987; 36(3):317-322.
13. Kim JM, Yun-choi HS. Anti-platelet effects of flavonoids and flavonoids-glycosides from *Sophora Japonica*. *Arch Pharm Res* 2008; 31(7):886-890.
14. Nardini M, Natella F and Scaccini. Role of dietary polyphenols in platelet aggregation. A review of the supplementation studies. *Platelets* 2007; 18(3):224-243.
15. Ziaee A, Zamansoltani F, Nassiri AM, Abbasi E. Effects of rutin on lipid profile in hypercholesterolaemic rats. *Basic Clin Pharmacol Toxicol* 2009; 104(3):253-258.
16. Meng F, Liu R, Bai H, Liu BW, Liu Y. Inhibitory effect of quercetin, rutin and puerarin on HDL oxidation induced by Cu⁺². *Sichuan Da, Xue Xue Bao, Yi Xue Ban* 2004; 35(6):836-838.
17. Milde J, Elstner EF, Grassmann J. Synergistic inhibition of low-density lipoprotein oxidation by rutin, gamma-terpinene and ascorbic acid. *Phytomedicine* 11(2-3):105-113.
18. Krishna KM, Akula A, Gopisetty S, Gopal CRV, Chalam KM, Veeravalli KK, Gomedhikam JP. Partial reversal by rutin and quercetin of impaired cardiac function in streptozotocin-induced diabetic rats. *Can J Physiol Pharmacol* 2005; 83:343-355.
19. Bishnoi M, Chopra K, Kulkarni SK. Protective effect of rutin, a polyphenolic flavonoid against haloperidol-induced orofacial dyskinesia and associated behavioural, biochemical and neurological changes. *Fundamental and Clinical Pharmacol* 2007; 21(5):521-529.
20. Acker FAAV, Schouten O, Haenen GRMM, Vijgh WJFVD, Bast A. Flavonoids can replace alpha-tocopherol as an antioxidant. *FEBS Lett* 2000; 473(2):145-148.
21. Afanas EIB, Ostrakhovikh EA, Mikhal CEV, Ibragemova GA, Korkina LG. Enhancement of antioxidant and anti-inflammatory activities of bioflavonoid rutin by complexation with transition metals. *Biochem Pharmacol* 2001; 61(6):677-684.
22. Susun W. *Wise woman herbal for the childbearing year*. Ash tree publishing, Woodstock, Ny., 1986.
23. Spoerke, DG. *Herbal Medicines*. Woodbridge Press, Santa Barbara. 1980; 192.

24. Cantuti-Castelvetri I, Shukitt-Hale B, Joseph JA. Neurobehavioural aspects of antioxidants in aging. *Int J Dev Neurosci* 2000; 18(4-5):367-381.
25. Joseph JA, Shukitt-Hale B, Denisova NA, Bielinski D, Martin A, McEwen JJ, Bickford PC. Reversal of age related declines in neuronal signal transduction, Cognition and motor behavioural deficits with blueberry, spinach, or strawberry dietary supplementation. *J Neurosci* 1999; 19(18):8114-8121.
26. Winter E. Effects of an extract of Ginkgo biloba on learning and memory in mice. *Pharmacol Biochem Behav* 1991; 38:109-114.
27. Lee SC, Moon YS, You KH. Effects of red Ginseng saponins and nootropic drugs on impaired acquisition of ethanol-treated rats in passive avoidance performance. *J Ethnopharmacol* 2000; 69:1-8.
28. Sharma M, Gupta YK. Effect of chronic treatment of melatonin on learning and memory and oxidative deficiencies induced by intracerebroventricular injection of streptozotacin in rats. *Pharmacol Biochem Behav* 2001; 70:325-331.
29. Bieri JG, Corash L, Hubbard VS. Medicinal uses of vitamin E. *N Engl J Med* 1983; 308:1063-1071.
30. Sokol RJ. Vitamin E deficiency and neurological disease. *Annu Rev Nutr* 1988; 8:351-373.
31. Clarren SK, Smith DW. The fetal alcohol syndrome. *N Engl J Med* 1978; 298:1063-1067.
32. Colangelo W, Jones DG. The fetal alcohol syndrome: a review and assessment of the syndrome and its neurological sequelae. *Progr Neurobiol* 1982; 19:271-314.
33. Jones KL, Smith DW. Recognition of the fetal alcohol syndrome in early infancy. *Lancet* 1973; 2:999-1001.
34. Gavin CE, Kates B, Gerken LA, Rodier PM. Patterns of growth deficiency in rats exposed in utero to undernutrition, ethanol, or the neuroteratogen methylazoxymethanol (MAM). *Teratology*. 1994 Feb;49(2):113-121.
35. Lee MH, Haddad R, Rabe A. Developmental impairment in pregnancy of rats consuming ethanol during pregnancy. *Neurobehav Toxicol* 1980; 2:189-198.
36. Cartwright, Martina, M, Laura, LT, Susan MS. *Alcoholism* 1998; 32:42.
37. Kishore K, Singh M. Colchicine impaired learning and memory by induction of apoptosis in mice. *Bull Pure Appl Sci* 2003; 22A(2):127-132.
38. Kishore K, Singh M. Rutin attenuated experimental amnesia associated with apoptosis in mice. *Indian Drugs* 2004; 41(8):488-492.
39. Kishore K, Singh M. Rutin (Bioflavonoid) attenuated prenatal alcoholic amnesia. *Indian J Nat Prod* 2004; 20(3):22-26.
40. Middleton EJ, Drzewiecki G, Tatum J. The effects of citrus flavonoids on human basophil and neutrophil function. *Planta Med* 1987; 53:325-328.
41. Manthey JA, Grohmann K, Guthrie N. Biological properties of citrus flavonoids pertaining to cancer and inflammation. *Curr Med Chem* 2001; 8:135-153.
42. Volate SR, Davenport DM, Muga SJ, Wargovich. Modulation of aberrant crypt foci and apoptosis by dietary herbal supplement (quercetin, curcumin, silymarin, ginseng and rutin). *Carcinogenesis* 2005; 26(8):1450-1456.
43. Webster RP, Gawde MD, Bhattacharya RK. Protective effect of rutin, a flavonoid glycoside, on the carcinogen-induced DNA damage and repair enzymes in rats. *Cancer Lett* 1996; 109:185-191.

44. Galley P, Thiollet M. A double-blind, placebo-controlled trial of a new veno-active flavonoid fraction (S 5682) in the treatment of symptomatic capillary fragility. *Int Angiol* 1993; 12:69-72.
45. Petruzzellis V, Troccoli T, Candiani C, Guarisco R, Lospalluti M, Belcaro G, Dugall M. Oxerutins (Venoruton): efficacy in chronic venous insufficiency--a double-blind, randomized, controlled study. *Angiology* 2002; 53(3):257-63.
46. Manuel y Keenoy B, Vertommen J, De Leeuw I. The effect of flavonoid treatment on the glycation and antioxidant status in Type 1 diabetic patients. *Diabetes Nutr Metab* 1999; 12:256-263.
47. Guilhou JJ, Dereure O, Marzin L. Efficacy of Daflon 500 mg in venous leg ulcer healing: a double-blind, randomized, controlled versus placebo trial in 107 patients. *Angiology* 1997; 48:77-85.
48. Miller MJ. Injuries to athletes. Evaluation of ascorbic acid and water soluble citrus bioflavonoids in the prophylaxis of injuries in athletes. *Med Times* 1960; 88:313-316.
49. So FV, Guthrie N, Chambers AF. Inhibition of human breast cancer cell proliferation and delay of mammary tumorigenesis by flavonoids and citrus juices. *Nutr Cancer* 1996; 26:167-181.
50. Danielsson G, Jungbeck C, Peterson K. A randomised controlled trial of micronised purified flavonoid fraction vs placebo in patients with chronic venous disease. *Eur J Vasc Endovasc Surg* 2002; 23:73-76.
51. Turner RB, Fowler SL, Berg K. Treatment of the common cold with troxerutin. *APMIS* 2004; 112(9):605-611.
52. Clement DL. Management of venous edema:insights from an international task force. *Angiology* 2000; 51:13-17.