Current Topics in Nutraceutical Research Vol. 3, No. 4, pp. 259-266, 2005
ISSN 1540-7535 print, Copyright © 2005 by New Century Health Publishers, LLC
www.newcenturyhealthpublishers.com

MOMORDICA COCHINCHINENSIS, ROSA ROXBURGHII, WOLFBERRY, AND SEA BUCKTHORN—HIGHLY NUTRITIONAL FRUITS SUPPORTED BY TRADITION AND SCIENCE

D. S. Burke, C.R. Smidt and L.T. Vuong*

Pharmanex Research Institute, Pharmanex LLC, 75 West Center Street, Provo, UT 84601, USA, and
*Vitalea Science, Inc, 1233 E. Beamer Street, Unit C, Woodland, CA 95776, USA

[Received August 14, 2005; Accepted October 10, 2005]

ABSTRACT: ***Most diets in developed nations fall far short of recommended fruit and vegetable, and thus key nutrient, intake. Momordica cochinchinensis (gac), indigenous to Southeast Asia, contains high concentrations of lycopene and beta-carotene. In Vietnam, gac is prized by natives for promoting longevity and vitality. In a supplementation trial among Vietnamese children, gac increased serum vitamin A levels more than synthetic beta-carotene. Rosa roxburghii (cili), native to southwest China and traditionally used to combat stress and aging, is very rich in vitamin C and other phytonutrients. In humans, cili enhanced immunity and raised erythrocyte superoxide dismutase (SOD). Lycium chinense (wolfberry), also of Chinese origin, and traditionally used for longevity, wellness, and vision, is very rich in highly utilizable zeaxanthin. In animals, wolfberry showed immune modulating and antioxidant actions, and in humans, significantly increased blood SOD. Hippophae rhamnoides (sea buckthorn), native to Siberia and the Himalayas and traditionally used to expel phlegm and promote digestion, was shown in animals to have liver-protective and antioxidant activity. In humans, sea buckthorn greatly increased the dietary intake of flavonoids and vitamin C, and showed cardiovascular benefits. Thus, due to their nutritional value, intake of these fruits may greatly enhance the diet's healthfulness.***

KEY WORDS: Antioxidants, Carotenoids, Hippophae rhamnoides, Lycium chinense, Momordica cochinchinensis, Rosa roxburghii

Corresponding Author: Douglas S. Burke, Ph.D., Pharmanex Research Institute, Pharmanex LLC, 75 West Center Street, Provo, UT 84601, USA; Fax: (801)-345-2799; E-mail: dburke@pharmanex.com

INTRODUCTION

Over the past 25 years, a large number of human studies have led to the consensus that eating 5-9 servings of fruits and vegetables can help prevent many chronic diseases, and that most people do not attain this level of intake. Many health benefits can be attributed to the vitamins, minerals, antioxidants, carotenoids and other phytonutrients present in these foods. Thus, it would be desirable to add fruits with very high levels of these nutrients to the diet. There are four lesser-known fruits that have extraordinary nutritional value: Momordica cochinchinensis (gac), Rosa roxburghii (cili), Lycium Chinense (wolfberry), and Hippophae rhamnoides (sea buckthorn). These are evaluated in this review for antioxidant potency, nutritional content, traditional folklore usage, and scientific documentation of health benefits.

GAC (MOMORDICA COCHINCHINENSIS)

Traditional uses and characteristics

To native people, gac is valued for many important health benefits. Grown in Vietnam and other areas in Southern Asia, gac is esteemed as "the fruit from heaven" (Voung, 2001), and is prized for its ability to promote longevity, vitality, and health. A large, bright-red fruit (Kuhnlein, 2004), gac is known as "sweet gourd". A perennial climber, the gac vine produces up to 60 fruits weighing 1-3 kg each in one season (Shadeque and Sharma Baruah, 1984). The seeds, known in traditional Chinese medicine (TCM) as "Mubiezi", are thought to have resolvent and cooling properties, and are used for liver and spleen disorders, wounds, hemorrhoids, bruises, swelling, and pus (De Shan, *et al.,* 2001). The Vietnamese often use gac in a dish called "xoi gac", prepared by mixing gac seed and pulp with cooked rice to impart a red color and distinct flavor (Voung, 2001; Vo Van Chi, 1997; Vu Dinh Trac, 1986). Since xoi gac is served at festive occasions such as weddings, the lunar New Year, and other important celebrations (Do, 1999), it is essential to mask the white color of rice, since white is considered the color of death (Vuong, 2001). In addition to their use in xoi gac, the seed membranes are used to make a tonic for children and lactating or pregnant women, and to treat "dry eyes" (xerophthalmia) and night blindness (Guichard and Bui, 1941). Gac is not well known worldwide,

but to indigenous people, gac is familiar and easy to grow, yet is seasonal and only available for three months each year, where harvesting begins in September and lasts until December. In Vietnam, the gac vine is often seen growing on lattices going to the entrances of rural homes (Vuong *et al.,* 2002). Gac may be underutilized in the diet worldwide because of its seasonality, regional lack of availability, and lack of awareness of its potential health value. (Vuong 2002; Vuong and King, 2003).

Nutritional content

Gac is becoming known as a premier source of carotenoids, especially beta-carotene and lycopene. Carotenoids were first identified in gac in 1941 (Guichard and Bui, 1941). However, it was only recently found that gac has beta-carotene and lycopene at very high levels, with those of lycopene being up to 308 µg/g in the seed membrane, about 10-fold higher than in other lycopene-rich fruits and vegetables (Vuong, 2001; Aoki *et al.,* 2002; Vuong *et al.,* 2003; Vuong *et al.,* 2005). In gac aril (pulp) mean levels of lycopene registered even higher, at 2227 µg/g of fresh material. The aril also comprised of high levels of fatty acids, ranging from 17% to 22% by weight (Voung and King., 2003; Ishida *et al.,* 2004). Oil extracted from the gac fruit aril (gac oil) showed a total carotenoid concentration of 5700 µg/ml, with 2710 µg of that being beta-carotene. This oil also included high levels of vitamin E (Vuong and King, 2003; Kuhnlein, 2004). The fatty acids in the aril are important for the absorption of fat-soluble nutrients including carotenoids in a diet typically low in fat (Kuhnlein, 2004; Vuong, 2002). In addition, gac oil was readily accepted by women and children of Vietnam, and consumption of the oil reduced lard intake (Vuong *et al.,* 2002; Vuong and King, 2003). Thus, gac provides an acceptable source of high levels of valuable antioxidants that have good bioavailability.

The potential health benefits of lycopene

Since the gac aril has over 70 times the lycopene/gram than tomatoes, this has interesting implications for prostate health. Epidemiological studies have shown that high intakes of tomatoes and tomato products, rich in lycopene, as well as high blood levels of lycopene, are significantly associated with decreased prostate cancer risk (Deming *et al.,* 2002; Giles *et al.,* 1997; Giovanucci *et al.,* 1995; Giovanucci *et al.,* 2002; Lu *et al.,* 2001; Vogt *et al.,* 2002). In a double-blind study of 26 men with newly diagnosed prostate cancer, lycopene was administered at 15 mg/day for three weeks before prostatectomy. A significantly increased number of subjects with tumors <4 mm in size, and decreased number with cancer of extra-prostatic tissue were observed (Kucuk *et al.,* 2001). These effects may be attributed to lycopene's antioxidant and DNA protective properties (Riso *et al.,* 1999; Porrini and Riso, 2000).

Clinical research

Human research has now confirmed that the beta-carotene in gac is highly bioavailable. In a double-blind study with 185 Vietnamese preschool children, some were given Xoi Gac containing 3.5 mg/day beta-carotene, while others were given an identical-looking dish containing 5 mg beta-carotene powder, for 30 days. At the end, the former group had significantly greater plasma levels of beta-carotene than the latter. Increases in plasma retinol, alpha-carotene, zeaxanthin, and lycopene levels were also significantly greater in children given gac (Vuong *et al.,* 2002). This is of great importance, because worldwide, vitamin A deficiency continues to be a major health problem and the leading cause of blindness in children (Maurin and Renard, 1997; Underwood and Arthur, 1996; Pinnock, 1995).

It is likely that the fatty acids in gac are what make its beta carotene more bioavailable than that of the synthetic form (Vuong *et al.,* 2002). Conversely, consumption of certain beta-carotene-rich foods has been shown to produce little increase in plasma beta-carotene or retinol concentrations (de Pee, *et al.,* 1998; Vuong, *et al.,* 2002).

CILI (ROSA ROXBURGHII)

Traditional uses

Cili, also known as sweet chestnut rose (van Rensburg, *et al.,* 2005), is a wild plant of southwest China (the Guizhou province), and has traditionally been used for longevity, cancer, immunity, and atherosclerosis (Zhang, *et al.,* 2001). Like gac, cili is of limited availability (van Rensburg, *et al.,* 2005).

Nutritional content

Cili has many components with antioxidant activity, which may contribute to its health benefits. Protecatechuic acid, a biphenol found in cili, displayed antioxidant activity, (Psotova *et al.,* 2003; Sroka and Cisowski, 2003; Yeh and Yen, 2003), and inhibited DNA scission by scavenging hydroxyl radicals (Ueda *et al.,* 1991). Cili is also rich in vitamins C and E, biotin, polyphenols, polysaccharides, zinc, strontium, and SOD (Zhang *et al.,* 2001). This antioxidant mileau may aid in the preservation of cili's vitamin C (Yoshida *et al.,* 1987), and contribute to cili's cardiovascular benefits (Zhang *et al.,* 2001; van Rensburg *et al.,* 2005).

Preclinical studies

Animal research has indicated that cili may have potential cardiovascular, antioxidant, and life extending benefits. In cholesterol-fed rabbits and quails, cili juice significantly ameliorated atherosclerosis, reduced plasma lipids, and increased red blood cell SOD activity (Zhang *et al.,* 2001; Hu, et al, 1994). In fruit flies given cili, the life span increased significantly, compared to a controls (Ma *et al.,* 1997).

Clinical research

Two interesting double-blind, placebo-controlled studies with cili have shown antioxidant, cardiovascular, and mental benefits. In the first study, 10 ml of a cili extract was administered twice daily to 60 healthy men and women aged 50-75 years for two months, while a placebo was given to 61 others of the same age range. After cili supplementation,

natural killer (NK) cell activity, and erythrocyte catalase, SOD and glutathione (GSH) levels all increased, while serum lipid peroxides decreased. Various indices of cardiovascular function and microcirculation improved, and peripheral vascular resistance was reduced. Simple and selective light reaction time decreased, and memory quotient improved. All these changes were significant, with no such changes in the control group (Ma *et al.,* 1997).

In another placebo-controlled, randomized, single-blind trial, 36 young, healthy, non-smoking subjects received either a placebo or encapsulated cili supplement for five weeks. The latter significantly increased reduced:oxidized GSH ratios in the blood, and plasma antioxidant capacity. This suggests that cili's antioxidants protect reduced GSH, thus producing the observed shift in the glutathione redox state (van Rensburg *et al.,* 2005)..

WOLFBERRY (LYCIUM BARBARUM OR L. CHINENSE)

Traditional uses

Wolfberry has a long history of traditional use, where in Northern and Central China, wolfberry has been used in TCM for 2000 years, for longevity, vision, wellness, and headaches. Additionally, since the Tang Dynasty (1000-1400 AD), wolfberry has been noted for its multiple traditional health benefits, such as nourishing the yin, strengthening the liver and kidney, and sustaining the blood. Anciently, people used wolfberries to make soup, stew, tea, and wine, or chew them like raisins.

Preclinical studies

In animals and *in vitro*, wolfberry has been shown to have interesting antioxidant, immune-enhancing, radioprotective, anti-aging, and other health benefits. *In vitro*, flavonoids from this fruit scavenged the potent superoxide and hydroxyl radicals in a concentration-dependent manner (Ren *et al.,* 1995), and in rats, wolfberry inhibited the lipid peroxidation of RBC membranes (Li *et al.,* 2002). In S180 tumor-bearing mice, this fruit augmented the immune system (Gan *et al.,* 2004), and a glycoconjugate from wolfberry, named LbGp2, showed marked immunoactivity (Peng and Tian, 2001). When given at high doses i.p. for seven consecutive days before irradiation, both the roots and aerial parts of wolfberry protected bone marrow from death in mice due to radiation (500 but not 250 mg/kg). This may have worked through enhancing the regeneration of hematopoietic stem cells due to enhanced post-irradiation repair or increased proliferation (Hsu *et al.,* 1999). In male and female fruit flies (Drosophila melanogaster), wolfberry increased the maximal lifespan, and in males, increased the average lifespan. In d-galactose-administered aged mice, wolfberry at 20 mg/kg/d increased the serum and liver levels of SOD and GSH peroxidase to levels higher than that of aged mice not given d-galactose. Wolfberry reduced lipofuscin levels below that found in control aged mice, and reduced MDA content dose-dependently, where the high dose reduced it to levels found in young mice (Wang *et al.,* 2002). Containing naturally occurring free-radical scavenging flavonoids, wolfberry has also shown potential hypotensive, hepatoprotective, anti-asthmatic (Huang *et al.,* 1998), hypoglycemic, and hypolipidemic effects (Luo *et al.,* 2004).

Human studies

With aging, oxidative stress is known to increase, and wolfberry has shown anti-aging effects in humans. In 25 Chinese subjects aged 64-80 years, who could care for themselves, ingestion of 50 g/d dry wolfberry fruit for 10 days significantly increased blood SOD and hemoglobin by 48 and12%, respectively, and decreased blood lipid peroxides by 65% (Li *et al.,* 1991). Wolfberry also improved some conditions associated with age. In another study, thirty-six of 42 healthy subjects (35 males and 7 females), aged an average of 68 years, were given 50 mg wolfberry extract twice daily for two months, and the other six served as controls. The wolfberry group showed dramatically decreased dizziness, fatigue, chest distress, sleep problems, and anorexia, while the control group showed much less pronounced changes (significance not assessed) (Li 1989).

Wolfberry is very rich in zeaxanthin, which showed good bioavailability. In a randomized, single-blind cross-over study with 12 volunteers, a balanced breakfast was co-administered with 5 mg 3R-3'R-zeaxanthin, either in non-esterified (synthetic), or in esterified (dipalmitate) form found in wolfberry, suspended in 150g yogurt. This was followed by a 3-week zeaxanthin-depletion period, after which treatments were reversed. Plasma zeaxanthin 24h area-under-the-curve, was significantly (~2-fold) greater with the esterified form (Breithaupt, *et al.,* 2004). Wolfberry has significant implications for ocular health. A number of studies support the protective role for zeaxanthin in the prevention of age-related eye diseases. For example, reduced risks of cataracts (Brown *et al.,* 1999; Chasan-Taber *et al.,* 1999) and ARMD (Seddon *et al.,* 1994) have been associated with high intakes of leafy green vegetables, which are rich sources of lutein and zeaxanthin. In addition, lower levels of serum (Bernstein *et al.,* 2002) and retinal (Bone *et al.,* 2001) zeaxanthin were found in ARMD patients compared to healthy controls. Many other studies have also indicated that zeaxanthin is important for ocular health (Beatty *et al.,* 2004; Bone *et al.,* 1985; Bone *et al.,* 1992; Bone *et al.,* 1993; Bone *et al.,* 2003; Mozzafarieh *et al.,* 2003; Gale *et al.,* 2003; Johnson *et al.,* 2002).

SEA BUCKTHORN (SB, HIPPOPHAE RHAMNOIDES)

Traditional uses and history

In Russia and China, SB has a rich history of many uses. In the Chinese Pharmacopoeia, SB is recognized for the following indications: expelling phlegm, arresting coughs, promoting digestion, removing food stagnancy, and promoting blood flow to remove blood stasis (Thomas *et al.,* 2004). The seed and pulp oils of SB have been traditionally used in Russia and China to treat skin disease (Yang *et al.,* 2000). In Russia, active

compounds have been investigated in the plant's fruits, leaves, and bark since the 1940s. SB reportedly had use as a fruit in the diet of Russian cosmonauts and the oil in a cream to protect them from solar radiation (Thomas *et al.,* 2004).

Preclinical studies

SB has been shown to have a wide variety of antioxidant and cell-protective benefits. In lymphocytes, SB inhibited chromium-induced free radical production, apoptosis, and DNA fragmentation, and restored antioxidant status to that of control cells. In addition, SB arrested the chromium-induced inhibition of lymphocyte proliferation. These observations suggest that SB has marked cytoprotective properties, which can be attributed to its antioxidant activity (Geetha *et al.,* 2002; Geetha *et al.,* 2003). SB also protected the functional integrity of mitochondria from radiation-induced oxidative stress (Goel *et al.,* 2005).

In albino rats, the leaf extract of SB exerted significant protection against chromium-induced oxidative injury (Geetha *et al.,* 2003). In rats given given i.p. nicotine for three weeks, SB and vitamin E prevented nicotine-induced increases in MDA. SB but not vitamin E also prevented nicotine-induced reductions in erythrocyte SOD. In addition, compared with rats given nicotine only or nicotine plus vitamin E, those given SB had increased erythrocyte GSHPx activity. Plasma vitamin A levels were higher in both the vitamin E and SB groups, compared with the nicotine and control groups (Suleyman *et al.,* 2002). A study with mice demonstrated that SB may have liver-protective ability. In animals treated with carbon tetrachloride, acetaminophen, and ethyl alcohol, SB significantly reduced the increases in SGOT, SGPT, and MDA induced by these agents, and the decrease in reduced glutathione induced by acetaminophen. This indicates reduced injury to the liver from lipid peroxidation (Lipkan and Oliinyk, 2000; Cheng 1990; Cheng *et al.,* 1992; Cheng *et al.,* 1994).

SB's free-radical scavenging activity is due in large part to its phenolic fractions (Gao *et al.,* 2000), with the predominate polyphenols being flavonols, and catechins and phenolic acids representing minor portions. Vitamin C is also a major antioxidant found in SB (Rosch *et al.,* 2003).

Clinical research

In humans, SB or its components have been shown to have cardiovascular benefits, and to increase the intake of important dietary nutrients, especially flavonoids and vitamin C. The total flavones of SB, when given for 8 weeks to 35 hypertensive patients, prevented supine isometric exercise-induced increases in heart rate, blood pressure, and plasma catecholamine concentrations (Zhang *et al.,* 2001). SB pulp oil at 5 grams/day induced a significant increase in serum HDL-C in patients with atopic dermatitis (Yang *et al.,* 1999). In 20 healthy male volunteers given either SB juice or a placebo for 8 weeks, SB increased daily intakes of beta-carotene, alpha-tocopherol, flavonoids, and vitamin C by 1.0, 3.2, 355, and 462 mg/d, respectively (Eccleston *et al.,* 2002).

CONCLUSIONS

Gac, cili, wolfberry, and sea buckthorn are all very highly nutritious fruits that will, individually or in combination, greatly enhance the healthfulness of a diet. Clinical research has shown that one or more of these fruits supported normal vitamin A levels and enhanced bodily antioxidant levels, cardiovascular and mental health, and immunity. Gac and wolfberry, with their high level of bioavailable carotenoids, may also promote prostate health and protect the eyes from age-related macular degeneration and cataracts. Cili, with its powerful antioxidant mileau, may help fight some of the signs of aging, as supported by its extension of life in fruit flies, and, in older adults, its enhancement of some aspects of cardiovascular and mental function, and reduction of oxidative stress. Extensive preliminary evidence suggests that SB has powerful antioxidant effects and thus the ability to reduce oxidative stress in many situations, such as exhaustive exercise, driving in heavy traffic, smoking, weight loss, etc. SB has also been shown to protect organs such as the liver and circulatory system. It appears that consumption of these fruits can provide a wide range of potential health benefits, and thus, the increase of public awareness and intake of these fruits may be of significant value to society.

REFERENCES

Aoki, H., Kieu, N.T., Kuze, N., Tomisaka, K. and Van Chuyen, N. (2002). Carotenoid pigments in GAC fruit Momordica cochinchinensis SPRENG). Biosciece. *Biotechnology, and Biochemistry* **66**,:2479-82.

Beatty S., Nolan, J., Kavanagh, H. and O'Donovan, O. (2003) Macular pigment optical density and its relationship with serum and dietary levels of lutein and zeaxanthin. *Archives of Biochemistry and Biophysics* **430**:70-76.

Bernstein, P.S., Zhao, D.Y., Wintch, S.W., Ermakov, I.V., Mcclane, R.W. and Gellermann, W. (2002) Resonance Raman measurement of macular carotenoids in normal subjects and in age-related macular degeneration patients. *Ophthalmology* **109**:1780-1787.

Bone, R.A., Landrum, J.T. and Tarsis, S.L. (1985). Preliminary identification of the human macular pigment. *Vision Research* **25**, 1531-1535.

Bone, R.A., Landrum, J.T., Fernandez, L. and Tarsis, S.L. (1988). Analysis of the macular pigment by HPLC: retinal distribution and age study. *Investigative Ophthalmology and Visual Sciences* **29**, 843-849.

Bone, R.A., Landrum, J.T. and Caines A. (1992). Optical density spectra of the macular pigment *in vivo* and *in vitro*. *Vision Research* **32**, 105-110.

Bone, R.A., Landrum, J.T., Hime, G.W., Cain, S.A. and Zumor, J. (1993) Stereochemistry of the human macular

carotenoids. *Investigative Ophthalmology and Visual Science* **34**, 2033-2040.

Bone, R.A., Landrum, J.T., Mayne, S.T., Gomez, C.M., Tibor, S.E. and Twaroska, E.E. (2001) Macular pigment in donor eyes with and without AMD: a case-control study. *Investigative Ophthalmology and Visual Science* **42**, 235-240.

Bone, R.A., Landrum, J.T., Guerra, L.H. and Ruiz, C.A. (2003) Lutein and zeaxanthin dietary supplements raise macular pigment density and serum concentrations of these carotenoids in humans. *Journal of Nutrition* **133**, 992-998.

Breithaupt, D.E., Weller, P., Wolters, M. and Hahn, A. (2004). Comparison of plasma responses in human subjects after the ingestion of 3R,3R'-zeaxanthin dipalmitate from wolfberry. *British Journal of Nutrition* **91**, 707-713.

Brown, L., Rimm, E.B., Seddon, J.M., Giovannucci, E.L., Chasan-Taber, L., Spiegelman, D., Willett, W.C., Hankinson, S.E. (1999) A prospective study of carotenoid intake and risk of cataract extraction in US men. *The American Journal of Clinical Nutrition* **70**, 517-24.

Chasan-Taber, L., Willett, W.C., Seddon, J.M., Stempfer, M.J., Rosner, B., Colditz, G.A., Speizer, F.E. and Hankinson, S.E. (1999) A prospective study of carotenoid and vitamin A intakes and risk of cataract extraction in US women. *American Journal of Clinical Nutrition* **70**, 509-516.

Cheng, T.J. (1992) [Protective action of seed oil of Hippophae rhamnoides L. (HR) against experimental liver injury in mice]. Zhonghua Yu Fang Yi Xue.*Za Zhi* **26**, 227-9.

Cheng. T., Li, T., Duan, Z., Cao, Z., Ma, Z. and Zhang, P. (1990) [Acute toxicity of flesh oil of Hippophae rhamnoides L. and its protection against experimental hepatic injury]. *Zhongguo Zhong Yao Za Zhi* **15**, 45-7, 64.

Cheng, T.J., Pu, J.K., Wu, L.W., Ma, Z.R., Cao, A. and Li TJ. (1994) An preliminary study on hepato-protective action of seed oil of Hippophae rhamnoides L. *Zhongguo Zhong Yao Za Zhi* **19**, 367-70,384.

Deming, D.M., Boileau, T.W-M., Heintz, K.H., Atkinson, C.A. and Erdman, J.W., Jr. (2002) Carotenoids: Linking chemistry, absorption, and metabolism to potential roles in human health and disease. In: Cadenas, E. and Packer, L. (Eds), Handbook of Antioxidants (New York: New York: Marcel-Dekker), pp. 189-221.

de Pee, S., West, C.E., Permaesih, D., Martuti, S., Muhilal, and Hautvast, J.G.A.F.. (1998) Orange fruit is more effective than are dark-green, leafy vegetables in increasing serum concentration of retinol and ß-carotene in schoolchildren in Indonesia. *American Journal of Clinical Nutrition* **68**,:1058-67.

De Shan, M., Hu, L.H. and Chen ZL. (2001) A new multiflorane triterpenoid ester form Momordica cochinchinensis Spreng. *Natural Product Letters* **15**, 139-145.

Do, T.L..(1999) Nhung Cay Thuoc va Vi Thuoc Viet Nam [Medicinal Plants and Drugs of Vietnam]. Hanoi: (Nha Xuat Ban Khoa Hoc va Ky Thuat).

Eccleston, C., Baoru, Y., Tahvonen, R., Kallio, H., Rimbach, G.H. and Minihane, A.M.. (2002) Effects of an antioxidant-rich juice (sea buckthorn) on risk factors for coronary heart disease in humans. *Journal of Nutritional Biochemistry* **13**, 346-54.

Gale, C.R., Hall, N.F., Phillips, D.I.W., and Martyn, C.N. (2003) Lutein and zeaxanthin status and risk of age-related macular degeneration. *Investigative Ophthalmology & Visual Science* **44**, 2461-2465.

Gan, L., Hua Zhang, S., Liang Yang, X. and Bi Xu H. (2004) Immunomodulation and antitumor activity by a polysaccharide-protein complex from Lycium barbarum. *Int Immunopharmacology* **4**, 563-9.

Gao, X., Ohlander, M., Jeppsson, N., Bjork, L and Trajkovski V. (2000) Changes in antioxidant effects and their relationship to phytonutrients in fruits of sea buckthorn (Hippophae rhamnoides L.) during maturation. *Journal of Agricultural and Food Chemistry* **48**, 1485-90.

Geetha, S., Sai, R.M., Singh, V., Ilavazhagan, G. and Sawhney, R.C.. (2002) Anti-oxidant and immunomodulatory properties of seabuckthorn (Hippophae rhamnoides)--an *in vitro* study. *Journal of Ethnopharmacology* **79**, 373-8.

Geetha, S., Sai Ram, M., Mongia, S.S., Singh, V., Ilavazhagen, G. and Sawhniey RC. (2003) Evaluation of antioxidant activity of leaf extract of Seabuckthorn (Hippophae rhamnoides L.) on chromium (VI) induced oxidative stress in albino rats. *Journal of Ethnopharmacology* **87**, 247-51.

Giles, G., Ireland, P. (1997) Diet, nutrition, and prostate cancer. *International Journal of Cancer* **72**, 13-17.

Goel, H.C., Gupta, S., Garg, A.P. and Bala, M. (2005) Protection of mitochondrial system by Hippophae rhamnoids L. Against radiation-induced oxidative damage in mice. *Journal of Pharmacy and Pharmacology* **57**, 135-43.

Grenado, F., Olmedilla, B. and Blanco I. (2003) Nutritional and clinical relevance of lutein in human health. *British Journal of Nutrition* **90**:487-502.

Guichard, F., and Bui, D.S.. (1941) La matiere colorante du

fruit du Momordica Cochinchinnensis Spr. *Annales de l'ecole Superieure de Medecine et de Pharmacie de l'Indochine* **V**, 41-42.

Hsu, H.Y., Yang, J.J., Ho, Y.H. and Lin, C.C. (1999) Difference in the effects of radioprotection between aerial and root parts of Lycium chinense. *Journal of Ethnopharmacology* **64**,:101-8.

Hu, W.Y., Bai, Y., Han, X.F. and He, W.H.. Anti-atherosclerosis effect of Rosa roxburghii tratt. *Chinese Pharmaceutical Journal* (Zhongguo yaoxue Zazhi) **29**, 529-532.

Huang, Y., Tan, A., Shen, Y. and Lu, J. (1998) [Scavenging effect of total flavonoids of lycium barbarum L on active oxygen radicals and inhibitory effects on heat output from L1210 cells]. *Wei Sheng Yan.Jiu* **27**, 109-11, 115.

Ishida, B.K., Turner, C., Chapman, M.H. and McKeon, T.A.. (2004) Faty acid and carotenoid composition of gac (Momordica cochinchinensis Spreng) fruit. *Journal of Agricultural and Food Chemistry* **52**, 274-278.

Johnson, E.J. (2002) The role of carotenoids in human health. *Nutrition in Clinical Care* **5**, 56-65.

Krinsky, N.J., Landrum, J.T. and Bone, R.A. (2003) Biologic mechanisms of the protective role of lutein and zeaxanthin in the eye. *Annual Review of Nutrition* **23**, 171-201.

Kucuk, O., Sarkar, F.H., Sark, W., Djuric, Z., Pollak, M.N, Khachik, F., Li, Y.W., Banerjee, M., Grignon, D., Bertram, J.S., Crissman, J.D., Pontes, E.J. and Wood, D.P., Jr. (2001) phase II randomized clinical trial of lycopene supplementation before radical prostatectomy. *Cancer Epidemiology Biomarkers & Prevention* **10**, 861-868.

Kuhnlein, H.V. (2004). Karat, Pulque, and Gac: Three shining starts in the traditional food galaxy. *Nutrition Reviews* **62**, 439-442.

Li, D.Y., Yuan, X.L., Xia, H.F., Ma, L., Guo, Z.Y., Shen, Y.Y. and Rong, Q.Z.. (1989) Preliminary clinical observations for effects of Ning Xia wolfberry extract on old peoples. *Chinese Traditional and Herbal Drugs* **20**, 26-28.

Li, G., Yang, J., Ren, B. and Wang, Z.. (2002) [Effect of lycium barbarum L on defending free radicals of mice caused by hypoxia]. *Wei Sheng Yan Jiu* **31**, 30-31.

Li, W., Dai, S.Z., Ma, W. and Gao, L. (1991) Effects of oral administration of Wolfberry on blood superoxide dismutase (SOD), hemoglobin (Hb) and lipid peroxide (LPO) levels in old people. *Chinese Traditional and Herbal Drugs* **22**, 251,268.

Lipkan, G.M. and Oliinyk OA. (2000) [Hepatoprotective effect of the sea buckthorn-and-pinks oil]. Likars'Ka .Sprava. 96-9.

Luo, Q., Cai, Y., Yan, J., Sun, M. and Corke, H. (2004) Hypoglycemic and hypolipidemic effects and antioxidant activity of fruit extracts from Lycium barbarum. *Life Science* **76**, 137-49.

Ma, Y.X., Zhu, Y., Wang, C.F., Wang, Z.S., Chen, S.Y., Shen, M.H., Gan, J.M., Zhang, J.G., Gu, O. and He, L. (1997) The aging retarding effect of 'Long-Life CiLi'. *Mechanisms of Ageing and Development* **96**, 171-80.

Maurin, J.F. and Renard, J.P. (1997) Ocular manifestations of vitamin A deficiency and their prevention. *Revue International Trachome Pathologie Oculaire Tropicale Subtropicale Sante Publique* **74**, 21-42.

Mozaffarieh, M., Sacu, S. and Wedrich, A (2003). The role of carotenoids, lutein, and zeaxanthin, in protecting against age-related macular degeneration: A review based on controversial evidence. *Nutrition Journal* **2**:20.

Peng, X. and Tian, G. (2001) Structural characterization of the glycan part of glycoconjugate LbGp2 from Lycium barbarum L. *Carbohydrate Research* **331**, 95-9.

Pinnock, C. Vitamin A.. *The Nursing Journal of India* **82**, 307-308.

Porrini, M. and Riso P. (2000) Lymphocyte lycopene concentration and DNA protection from oxidative damage is increased in women after a short period of tomato consumption. *Journal of Nutrition* **130**, 189-192.

Psotova, J., Lasovsky, J. and Vicar, J. (2003) Metal-chelating properties, electrochemical behavior, scavenging and cytoprotective activities of six natural phenolics. Biomed.Pap. Med Fac Univ Palacky.Olomouc.Czech.Repub. 147,:147-53.

Ren, B., Ma, Y., Shen, Y. and Gao, B. (1995) [Protective action of Lycium barbarum L. (LbL) and betaine on lipid peroxidation of erythrocyte membrane induced by H_2O_2]. *Zhongguo Zhong Yao Za Zhi* **20**, 303-4, inside.

Riso, P., Rinder, A., Santangelo, A. and Porrini, M. (1999) Does tomato consumption effectively increase the resistance of lymphocyte DNA to oxidative damage? *American Journal of Clinical Nutrition* **69**, 712-718.

Rösch, D., Bergmann, M., Knorr, D. and Kroh, L.W. (2003) Structure-antioxidant efficiency relationships of phenolic compounds and their contribution to the antioxidant activity of sea buckthorn juice. *Journal of Agricultural and Food Chemistry* **51**, 4233-9.

Seddon, J.M., Ajani, U.A., Sperduto, R.D., Hiller, R., Blair, N., Burton, T.C., Farber, M.D., Gragoudas, E.S., Haller, J., Miller, D.T., Yanmuzi, L.A. and Willett,W. (1994) Dietary carotenoids, vitamins A, C, and E, and advanced age-related macular degeneration: Eye Disease Case-Control Study Group. *Journal of the American Medical Association* **272**, 1413-1420.

Shaban, H. and Richter C. (2002) A2E and blue light in the retina: the paradigm of age-related macular degeneration. *Biological Chemistry* **383**, 537-545.

Shadeque, A. and Sharma Baruah, G.K. (1984) Sweet gourd : A popular vegetable of Assam. *Indian Farming* **34**, 25, 35.

Sies, H. and Stahl, W. (2003) Non-nutritive bioactive constituents of plants : lycopene, lutein and zeaxanthin. *Instructional Journal for Vitamin and Nutrition Research* **73**, 95-100.

Sroka, Z. and Cisowski, W.. (2003) Hydrogen peroxide scavenging, antioxidant and anti-radical activity of some phenolic acids. *Food and Chemical Toxicology* **41**, 753-8.

Suleyman, H., Gumustekin, K., Taysi, S., Keles, S., Oztasan, N., Aktas, O., Altinkaynak, K., Timur, H., Akcay, F., Akar, S., Dane, S. and Gul, M. (2002) Beneficial effects of Hippophae rhamnoides L. on nicotine induced oxidative stress in rat blood compared with vitamin E. *Biological and Pharmaceutical Bulletin* **25**, 1133-1136.

Thomas, S.C. Li and Thomas, H.J.. (2004) Sea Buckthorn (Hippophae rhamnoids L.): Production and Utilization. *HerbalGram* **62**, 74.

Ueda, J., Saito, N,. Shimazu, Y. and Ozawa, T. (1996) A comparison of scavenging abilities of antioxidants against hydroxyl radicals. *Archives of Biochemistry and Biophysics* **333**, 377-84.

Underwood, B.A. and Arthur, P. (1996) The contributions of vitamin A to public health. *FASEB Journal* **10**, 1040-1049.

Van Rensburg, C.J., Erasmus, E., Loots, D.T., Oosthuizen, W., Jerling, J.C., Kruger, H.S., Louw, R., Brits, M,. and van der Westhuizen, F.H. (2005). Rosa roxburghii supplementation in a controlled feeding study increases plasma antioxidant capacity and glutathione redox state. *European Journal of Clinical Nutrition* online print, March 24.

Vogt, T.M., Mayne, S.T., Graubard, B.I., Swanson, C.A., Sowell, A.L., Schoenberg, J.B., Swanson, G.M., Greenberg, R.S., Hoover, R.N., Hayes, R.B., and Zeigler, R.G. (2002) Serum lycopene, other serum carotenoids, and risk of prostate cancer in US Blacks and Whites. *American Journal of Epidemiology* **155**, 1023-1032.

Vo-Van-Chi. (1997) Tu Dien Cay Thuoc Viet Nam [A Dictionary of Medicinal Plants of Vietnam]. (Ho-Chi-Minh City, Vietnam: Nha Xuat Ban Y Hoc).

Vu Dinh Trac. (1986) 100 Cay Thuoc, Van Linh Ba Chung [100 medicinal plants, highly effective for many diseases]. Hanoi: Y Hoc Viet-Nam Hoi Huu Xuat Ban), p.175.

Vuong, L. Vietnam Journal 1, Oct 2001.

Vuong, L.T., Dueker, S.R. and Murphy, S.P.. (2003) Plasma beta-carotene and retinol concentrations of children increase after a 30-d supplementation with the fruit Momordica cochinchinensis (gac). *American Journal of Clinical Nutrition* **75**,:872-9.

Vuong, L.T. and King, J.C.. (2003) A method of preserving and testing the acceptability of gac fruit oil, a good source of beta-carotene and essential fatty acids. *Food and Nutrition Bulletin* **24**, 224-30.

Vuong, L.T., Franke, A.A., Custer, L.J. and Murphy, S.P. (2005) Momordica cochinchinensis SPENG. (Gac) fruit contains high beta-carotene and lycopene levels. *Journal of Food Composition and Analysis*. In press.

Wang, J.H., Wang, H.Z., Zhang, M., and Zhang, S.H.. (2002) Anti-aging function of polysaccharides from Fructus lycii. *Acta Nutrimenta Sinica* **24**, 189-191.

Yang, B., Kalimo, K.O., Mattila, L.M., Kallio, S.E., Katajisto, J.K., Peltola, O.J. and Kallio, H.P.. (1999) Effects of dietary supplementation with sea buckthorn (Hippophae rhamnoides) seed and pulp oils on atopic dermatitis. *Journal of Nutritional Biochemistry* **10**, 622-30.

Yang, B., Kalimo, K.O., Tahvonen, R.L., Mattila, L.M., Katajisto, J.K. and Kallio, H.P. (2000) Effect of dietary supplementation with sea buckthorn (Hippophae rhamnoides) seed and pulp oils on the fatty acid composition of skin glycerophospholipids of patients with atopic dermatitis. *Journal of Nutritional Biochemistry* **11**, 338-340.

Yeh, C.T. and Yen, G.C.. (2003) Effects of phenolic acids on human phenolsulfotransferases in relation to their antioxidant activity. *Journal of Agricultural and Food Chemistry* **51**, 1474-9.

Yeum, K.J., Taylor, R.A., Tang,G. and Russell, R.M. (1995) Measurement of carotenoids, retinoids, and tocopherols in human lenses. *Investigative Ophthalmology and Visual Sciences* **36**, 2756-2761.

Yoshida, Y., Chen, X.M., Hatano, T., Fukushima, M. and Okuda, T. (1987) Tannins and related polyphenols of Rosaceous medicinal plants. IV. Roxbins A and B from Rosa

roxburghii fruits. *Chemical and Pharmaceutical Bulletin* **38**, 1817-1822.

Zhang, C., Liu, X., Qiang, H., Li, K., Wang, J., Chen, D. and Zhuang, Y.(2001) Inhibitory effects of rosa roxburghii tratt juice on *in vitro* oxidative modification of low density lipoprotein and on the macrophage growth and cellular cholesteryl ester accumulation induced by oxidized low density lipoprotein. *Clinica Chimica Acta* **313**, 37-43.

Zhang, X., Zhang, M., Gao, Z., Wang, J. and Wang, Z. (2001) Effect of total flavones of Hippophae rhamnoids L. on sympathetic activity in hypertension. *Hua Xi Yi Ke Da Xue Xue Bao* **32**, 547-550.