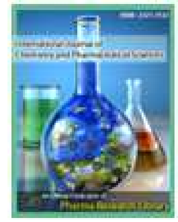
International Journal of Chemistry and Pharmaceutical Sciences

Journal Home Page: www.pharmaresearchlibrary.com/ijcps



Review Article **Open Access**

Hilarious Ecstasy of Lycopene and Resveratrol for Wellbeing

Manisha Mavai [1]*, Vikram Singh Chauhan[2], Sangeeta Agarwal[3], Raaz K Maheshwari[4]

[1]*Department of Physiology, MG Medical College, Sitapura, Jaipur, Rajasthan, India*
[2]*Department of Botany, SBRM Govt. PG College, Nagaur, Rajasthan, India*
[3]*Department of Chemistry SSVPG College, Hapur, Gajiabad, UP, India*
[4]*Department of Chemistry, SBRM Govt. PG College, Nagaur, Rajasthan, India*

A B S T R A C T

In recent years, there has been a great deal of attention toward the field of free radical chemistry. Free radicals are produced by cellular metabolism involve oxidation, environmental and other factors, with very high reactivity. Antioxidants work by stabilizing free radical induced destabilization of other molecules and cell damage by preventing their formation, scavenging them. Antioxidants cannot be formed by body spontaneously. Instead, we must consume them in our diet. This manuscript provides a brief overview on ROS mediated cellular damages, role of dietary antioxidants and background information about lycopene and resveratrol in many different diseases. Lycopene is a phytochemical that belongs to a group of pigments known as carotenoids. It is allegedly a more effective antioxidant than other of its carotenoid cousins, also known to help prevent as well as the prevention and treatments of many illnesses and diseases. Grapes are amazingly versatile; the fruit and it's skin, seeds and leaves are all put to good use. Resveratrol, a popular supplement is extracted from the skin of the grape with multiple beneficial effects on human body.

Keywords: Antioxidants, free radicals, oxidation, ROS

A R T I C L E   I N F O

CONTENTS

Article History: Received 18 February 2015, **Accepted** 19 March 2015, **Available Online** 27 April 2015

***Corresponding Author**
Manisha Mavai
Department of Physiology,
M.G. Medical College College,
Sitapura, Jaipur, Rajasthan, India
Manuscript ID: IJCPS2512

PAPER-QR CODE

Citation: Manisha Mavai, et al. Hilarious Ecstasy of Lycopene and Resveratrol for Wellbeing. *Int. J. Chem, Pharm, Sci.*, 2015, 3(4): 1653-1658.

1. Introduction

A healthy cell has a mortal enemy which is called a "free radical." Free radicals constantly seek out healthy cells and attack their vulnerable outer membranes eventually causing cellular degeneration and death. The recent growth in the knowledge of free radicals and ROS in biology is producing a medical revolution that promises a new age of health and disease management (Aruoma OI, 2003). There is no animal life without oxygen consumption and its conversion to water with the production by leakage from mitochondrial electron transport of free radicles (Wahlqvist ML, 2013) in the course of oxidative phosphorylation and the production of ATP as the ultimate and immediate source of energy (Aruoma O, 1999). Most of the potentially harmful effects of oxygen are due to the formation and activity of a number of chemical compounds, known as ROS, which have a tendency to donate oxygen to other substances (Aruoma OI, 1994). Free radicals are atoms or molecules containing one or more unpaired electrons, in an atomic orbit, making them very "reactive" (Surai, 2003). The extreme reactivity driven by a desire to acquire another electron underlies their ability to interact with and ultimately damage tissue. Biologically relevant molecules such as DNA, proteins, lipids and carbohydrates are damaged.

Free radicals and other ROS are derived either from normal essential cellular metabolism in the human body or from external sources such as exposure to X-rays, ozone, cigarette smoking, air pollutants and industrial chemicals (Bagchi K and Puri S, 1998).The most important oxygen-containing free radicals in many disease states are hydroxyl radical, superoxide anion radical, hydrogen peroxide, oxygen singlet, hypochlorite, nitric oxide radical and peroxynitrite radical (Young IS and Woodside JV, 2001). The super oxide radical is the main free radical produced in living cells and the electron transport chain in the mitochondria is considered to be responsible for it. Free radicals generated naturally during oxidative metabolism if present in excess react with fatty acids to form fatty acid hydroperoxides which can then induce a chain reaction forming further free radicals and hydroperoxides: if the chain reaction is not terminated cell damage will occur. The activation of macrophages in stress conditions is another important source of free radical generation (Schwarz, 1996). Because free radicals are toxic to cells, the body has developed a sophisticated antioxidant system that depends on antioxidant nutrients.

Antioxidants are compounds that protect cells from the damage caused by oxidation. Anti means "against," and antioxidants work against, or prevent oxidation. The body cannot form antioxidants spontaneously. Instead, we must consume them in our diet. Antioxidants can eliminate free radicals and other reactive oxygen and nitrogen species, and these reactive species contribute to most chronic ailments. Antioxidants terminate these chain reactions by removing free radical intermediates and inhibit other oxidation reactions by being oxidized themselves. As a result, antioxidants are often reducing agents such as thiols, ascorbic acid or polyphenols (Sies, 1997).

Figure 1

Antioxidants are abundant in fruits and vegetables, as well as in other foods including nuts, grains and some meats, poultry and fish. The list below describes food sources of common antioxidants. Beta-carotene is found in many foods that are orange in color, including sweet potatoes, carrots, cantaloupe, squash, apricots, pumpkin and mangoes. Some green, leafy vegetables, including collard greens, spinach and kale, are also rich in betacarotene (Borek C, 1991). Lycopene is a potent antioxidant found in tomatoes, watermelon, guava, papaya, apricots, pink grapefruit, blood oranges and other foods. Estimates suggest 85% of American dietary intake of lycopene comes from tomatoes and tomato products (Xianquan et al, 2005; Rodriguez-Amaya, 2003). It is hypothesized that antioxidants originating from foods may work as antioxidants in their own right in vivo, as well as bring about beneficial health effects through other mechanisms, including acting as inducers of mechanisms related to antioxidant defense (Kenser TW et al, 2007; Jeong WS et al. 2006), longevity (Baur JA et al, 2006; Wood JG et al, 2004), cell maintenance and DNA repair (Astley SB et al, 2004). This review highlights the scientific documentation of lycopene and resveratol as a therapeutic agent.

Figure 2

Amazing Lycopene

Lycopene, from the neo-Latin lycopersicum, the tomato species is a bright red carotene and carotenoid without provitamin-A activity, found in many fruits and vegetables. It is a red, fat-soluble pigment found in certain plants and microorganisms, where it serves as an accessory light-gathering pigment and protects them from ultraviolet B radiation. Gac fruit (*Momordica cochinchinensis*); tomatoes (*Lycopersicon esculentum*); and tomato products, including ketchup, tomato juice, and pizza sauce, are the more bioavailable sources of lycopene (Arab L and Steck S, 2000).

Gac fruit contains 2,227 mcg/g lycopene; tomato contains 31 mcg/g (Betty K et al, 2004). As all tomato products contain high concentrations of lycopene, they are, at the same time, the most important source of this carotenoid for humans, accounting for over 85% of all dietary sources (Mangels AR, 1993). Lycopene is also found in watermelon, papaya, pink grapefruit, and pink guava.

Structural Background

Lycopene is a 40 carbon acyclic, highly unsaturated straight chain hydrocarbon with a total of 13 double bonds, 11 of which are conjugated. This unique nature of the lycopene molecule makes it a very potent antioxidant. In vitro studies have shown lycopene to be twice as potent as β-carotene and ten times that of α-tocopherol in terms of its singlet oxygen quenching ability (Rao LG et al, 2003). The chemical name of lycopene is 2,6,10,14,19,23,27,31-octamethyl-2,6,8,10,12,14,16,18,20,22,24,26,30-dotria contatridecaene. It occurs in the all-*trans* and various *cis* configurations. Naturally-occurring lycopene consists predominantly of all-*trans*-lycopene.

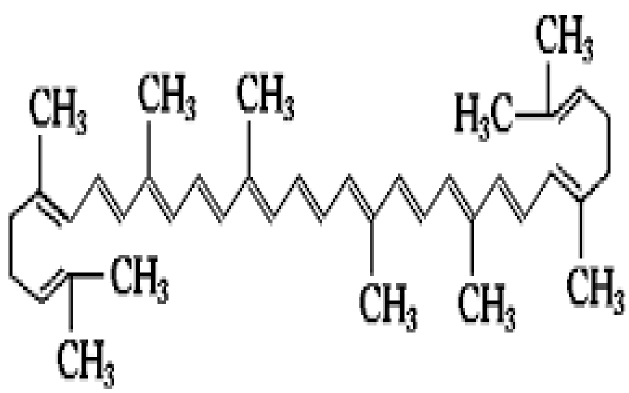


Figure 3

Bioavailbility

Lycopene is more bioavailable in processed and cooked tomato products than in fresh tomatoes (Rao AV and Agarwal S, 1999). It is ingested in natural trans form (eg, in raw tomatoes), which is poorly absorbed; heat processing tomatoes and tomato products induces isomerization of lycopene from all-trans to cis configuration, in turn increasing its bioavailability (Micozzi MS et al, 1992). Lycopene content of common fruits and vegetables (Clinton SK, 1998; Mangels AR, 1993).

Table 1

Lycopene content [mg/100 g wet basis]	Source
0.7–20	Fresh tomatoes
3.7	Cooked tomatoes
2.3–7.2	Fresh watermelon
2.0–5.3	Fresh papaya
5.2–5.5	Pink guava
0.4–3.4	Pink grapefruit
0.01–0.05	Apricot

2. Applications

Epidemiology studies have provided evidence that high consumption of tomatoes effectively lowers the risk of reactive oxygen species (ROS)-mediated diseases by improving the antioxidant carotenoid reported to be more stable and potent singlet oxygen quenching agent compared to other carotenoids.

Health Benefits

In addition to its antioxidants properties, lycopene shows an array of biological effects including cardio protective, anti-inflammatory, anti-mutagenic, anti-carcinogenic activities (Hamid et al, 2010), prevention of osteoporosis, idiopathic male infertility, as an adjuvant therapy in neuropathy (Krishnaveni M et al, 2012) anti-aging and increase immunity. As Food Additive and raw material of health products, it is widely used in the field of food and health products. Because of its excellent whitening, anti-wrinkle, anti-oxidation and the effect of UV resistance, it is also widely used in the field of cosmetics.

Amazing Resveratrol

Grapes (Vitis vinifera) have been heralded for their medicinal and nutritional value for thousands of years (Khan GM et al, 2012). Grape (Vitis vinifera) is one of the world's largest fruit crops. It is also one of the most commonly consumed fruits in the world both as fresh fruit (table grape) and processed fruit (wine, grape juice, molasses, and raisins) Percival SS (2009); Schamel G (2006). This fruit is widely used in making wine. It contains powerful antioxidants in all forms: whole grapes, red wine made from grape skins and grape seed oil and extracts. This tasty fruit is one of the best examples of the blurry line between food and medicine. The beneficial effects of grape and relevant grape-derived food products are believed to be related to a variety of bioactive components in grapes (Vislocky LM and Fernandez ML, 2010; Prasain JK et al, 2010). One major group of these components is phenolic antioxidants typically including anthocyanins, catechins, resveratrol, phenolic acids, and procyanidins (Frayne RF, 1986). Grape seed extract of Vitis vinifera L. has in vivo antioxidant property and could be as important as vitamin E in preventing oxidative damage in tissues by reducing the lipid oxidation and/or inhibiting the production of free radicals (Xia EQ et al, 2010). Grape skins contain the powerful antioxidant compound resveratrol, which has been found to have a number of health benefits. It is one of the most prominent bioactive components in grapes.

Chemical Structure

Resveratrol (3,5,4'-trihydroxystilbene) is a stilbenoid, a derivate of stilbene. It exists as two geometric isomers: *cis*- (*Z*) and *trans*- (*E*). The *trans*- and *cis*-resveratrol can be either present in free form or in bound form to glucose. The when *trans*- form exposed to ultraviolet irradiation, it isomerizes to the *cis*- form, a process called photo-isomerization.

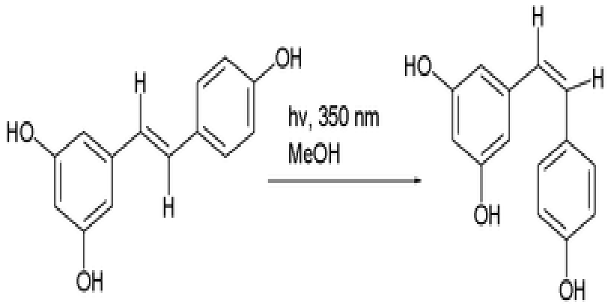


Figure 4

Bioavailbility:

Resveratrol (3,5,4 trihydroxy-*trans*-stilbene) is a stilbenoid, one of the most widespread stilbenes ($C_{14}H_{12}O_3$), a type of natural phenol, and a phytoalexin produced naturally by several plants against the growth of pathogens such as bacteria or fungi (Fremont, Lucie 2014). Food sources of resveratrol include the skin of grapes, blueberries, raspberries and mulberries (Jasiński M et al 2013). It is found in grapes and wine. The levels of resveratrol found in wine vary greatly, but is generally more abundant in red grapes and red wine. As the resveratrol content of wine is related to the length of time the grape skins are present during the fermentation process. Therefore the concentration is significantly higher in red wine than in white wine, because the skins are removed earlier during white-wine production, lessening the amount that is extracted (Kopp P, 1998). Grape juice, which is not a fermented beverage, is not a significant source of resveratrol.

Figure 5

Health Benefits of Red Wine and Resveratrol

Resveratrol is believed to afford strong antioxidant functions *in vitro* and in cell culture models. In 2004 Bradamante S et al revealed that resveratrol protect against heart-artery diseases by reducing cholesterol and harmful blot clots and hardening of the arteries. It also showed cancer chemopreventive and therapeutic effects (Szekeres T et al, 2011), and it can act as a neuroprotectant (Huang TC et al, 2011).Yes, resveratrol levels may be a key player in protecting the brain during a stroke by elevating specific enzyme levels. In vivo studies many investigators have clearly demonstrated that resveratrol intake has protective properties against multiple illnesses, also found to confer resistance to stress and to extend life span (Baur JA and Sinclair DA, 2006). More recently, concordant studies have also showed the beneficial effect of resveratrol *in vivo* on energy metabolism in diseases such as diet-induced obesity, insulin resistance, or aging-related syndromes (Lagouge M et al, 2006; Dasgupta B and Milbrandt J, 2007).

Figure 6

There is an increasing demand for effective approaches to produce resveratrol, as it has so many health benefits. Although this compound can be chemically synthesized (Chang S et al, 2002), the need for a safe and green product is in favor of using natural sources. The production of resveratrol directly from plants have a number of drawbacks, such as yield variation, pathogens, low purity and a long growth period. Therefore, plant cell culture is preferred as it overcomes those obstacles with supply of products in uniform quality (Donnez D et al, 2009), which is important to industrial bioprocesses. Grape cell suspension cultures have been reported to accumulate stilbenes including *trans*-resveratrol, *trans*/*cis*-piceid, ε-viniferin, δ-viniferin, pterostilbene and *trans*-astringin (Jeandet P et el, 1997) and (Donnez D et al, 2011).

3. Antioxidant Property

Antioxidant activities of grape phenolic compounds have been extensively investigated in vitro and in vivo. The antioxidant activities of grape phenolics have also been demonstrated in various model systems such as protecting low-density lipoprotein (LDL) against oxidation brought about by Cu^{2+}, oxygen-centered radical-generating AAPH (or) peroxynitrite-generating SIN-1 in vitro systems, preventing spleen cells from DNA damage induced by hydrogen peroxide (H_2O_2), and reducing oxidative stress in PC12 cells induced by addition of Fe^{2+} and *t*-butyl hydroperoxide (Fan P and Lou H, 2004; Chanvitayapongs S et al, 1997). However, in vivo studies examining antioxidant activity of grape extracts have shown inconsistent results.

4. Conclusion

Free radicals damage contributes to the etiology of many chronic health problems. All inevitably free radicals in the body will be quenched with intake of antioxidants thus, improving the health by reducing the risk of various diseases. Serum and tissue lycopene levels have also been inversely related with the chronic disease risk, but it is thought that antioxidant properties of lycopene are primarily responsible for its beneficial properties. Similarly, resveratrol is a substance with the very strong antioxidant functions and numerous health benefits for you and your body.

5. References

1. Wahlqvist ML. Antioxidant relevance to human health. Asia Pac J Clin Nutr 2013;22 (2):171-176.
2. Aruoma O. Free radicals, antioxidants and international nutrition. Asia Pac J Clin Nutr.1999; 8:55-63.
3. Kopp P. Resveratrol, a phytoestrogen found in red wine. A possible explanation for the conundrum of the 'French paradox'? European Journal of Endocrinology.1998. 138:619-620.
4. Aruoma OI. Methodological consideration for characterization for potential antioxidant actions of bioactive components in plants foods. Mutat Res. 2003; 532:9–20.
5. Aruoma OI. Nutrition and health aspects of free radicals and antioxidants. Food Chem Toxicol.1994; 32:671–683.
6. Sies H (1997). Oxidative stress: oxidants and antioxidants. Exp Physiol; 82(2): 291–295.
7. Schwarz, KB. Oxidative stress during viral infection: A Review: Free Radical Biology and Medicine.1996; 21: 641.
8. Rao LG, Gunns E, Rao AV. Lycopene : Its role in human health and disease. AGRO Food industry hi-tech. July/August 2003; 25-30.
9. Surai PF. Selenium-vitamin E interactions: Does 1 + 1 equal more than 2? In: Nutritional Biotechnology in the Feed and Food Industries (T.P. Lyons and K.A. Jacques, eds.) Nottingham University Press, Nottingham, UK.2003.
10. Bagchi K, Puri S. Free radicals and antioxidants in health and disease. East Mediterranean Health Jr.1998; 4:350–360.
11. Young IS, Woodside JV. Antioxidants in health and disease. J Clin Pathol. 2001; 54:176–86
12. Percival SS. Grape consumption supports immunity in animals and humans," Journal of Nutrition. 2009; 139(9) 1801S–1805S.
13. Schamel G. Geography versus brands in a global wine market. Agribusiness.2006; 22: 363–374.
14. Vislocky LM and Fernandez ML. "Biomedical effects of grape products," Nutrition Reviews.2010; 68(11): 656–670.
15. Prasain JK, Carlson SH, Wyss JM, "Flavonoids and age-related disease: risk, benefits and critical windows," Maturitas.2010; 66 (2): 163–171.
16. Frayne RF. Direct analysis of the major organic components in grape must and wine using high performance liquid chromatography," American Journal of Enology and Viticulture.1986; 37:281–287.
17. Fan P and Lou H. Effects of polyphenols from grape seeds on oxidative damage to cellular DNA,"Molecular and Cellular Biochemistry.2004; 267(1-2): 67–74.
18. Chanvitayapongs S, Draczynska-Lusiak B, Sun AY. Amelioration of oxidative stress by antioxidants and resveratrol in PC12 cells. NeuroReport.1997; 8(6): 1499–1502.
19. Fremont, Lucie. Biological Effects of Resveratrol. Life Sciences. Elservier, France. Retrieved 6 June 2014.
20. Jasiński M, Jasińska L, Ogrodowczyk M. Resveratrol in prostate diseases - a short review. Cent European J Urol.2013; 66(2): 144–149.
21. Khan GM, Ansari SH, Bhat ZA, Ahmad F. Study of Aging and Hepatoprotective Activity of Vitis vinifera L. Seeds in Albino Rats. Asian Pacific Journal of Tropical Biomedicine. 2012; S1770-S1774.
22. Xia EQ, Deng GF, Guo YJ, Li HB. Biological activities of polyphenols from grapes. Int J Mol Sci. 2010; 11: 622-646.
23. Bradamante S, Barenghi L, Villa A. Cardiovascular protective effects of resveratrol. Cardiovasc. Drug Rev.2004; 22: 169–188.
24. Szekeres T, Saiko P, Fritzer-Szekeres M, Djavan B, Jager W. Chemopreventive effects of resveratrol and resveratrol derivatives. Ann. N. Y. Acad. Sci. 2011; 1215: 89–95.
25. Huang TC, Lu KT, Wo YY, Wu YJ, Yang YL. Resveratrol protects rats from Aβ-induced neurotoxicity by the reduction of iNOS expression and lipid peroxidation. PLoS One.2011;6: e29102.
26. Chang S, Na Y, Shin HJ, Choi E, Jeong LS. A short and efficient synthetic approach to hydroxy (E)-stilbenoids via solid-phase cross metathesis. Tetrahedron Lett.2002; 43: 7445–7448.
27. Arab L, Steck S. Lycopene and cardiovascular disease. Am J Clin Nutr. 2000; 71(6):1691S-1695S.
28. Betty K, Charlotta T, Mary CH, McKeon Thomas A. Fatty acid and carotenoid composition of Gac (*Momordica cochinchinensis Spreng*) fruit. J Agri Food Chem. 2004; 52:274-279.
29. Rao AV, Agarwal S. Role of lycopene as antioxidant carotenoid in the prevention of chronic diseases: a review. *Nutr Res.*1999; 19(2):305-323.

30. Clinton, S.K. Lycopene: Chemistry, biology, and implications for human health and disease. Nutr. Rev. 1998, 56, 35–51.
31. Mangels AR, Holden JM, Beecher GR, Forman MR, Lanz E. Carotenoid content of fruits and vegetables: An evaluation of analytic data. J. Am. Diet. Assoc. 1993; 93: 284–296.
32. Hamid AA, Aiyelaagbe OO, Usman LA, Ameen OM, Lawal A. Antioxidants: Its medicinal and pharmacological applications. African Journal of Pure and Applied Chemistry.2010; 4(8):142-151. Donnez D , Jeandet P, Clement C, Courot E. Bioproduction of resveratrol and stilbene derivatives by plant cells and microorganisms. Trends Biotechnol.2009; 27:706–713.
33. Jeandet P, Breuil ACI, Adrian M, Weston LA, Debord S, Meunier P, et al. HPLC analysis of grapevine phytoalexins coupling photodiode array detection and fluorometry. Anal Chem.1997; 69:5172–5177.
34. Donnez D, Kim KH, Antoine S, Conreux A, De Luca V, Jeandet P *et al.* Bioproduction of resveratrol and viniferins by an elicited grapevine cell culture in a 2 L stirred bioreactor**.** Process Biochem.2011; 46 :1056–1062.
35. Baur JA, Sinclair DA. Therapeutic potential of resveratrol: the in vivo evidence. Nat Rev Drug Discov 2006, 5:493-506.
36. Lagouge M, Argmann C, Gerhart-Hines Z, Meziane H, Lerin C, Daussin F, Messadeq N, Milne J, Lambert P, Elliott P *et al*. Resveratrol improves mitochondrial function and protects against metabolic disease by activating SIRT1 and PGC-1alpha. Cell. 2006, 127:1109-1122.
37. Dasgupta B, Milbrandt J: Resveratrol stimulates AMP kinase activity in neurons. Proc Natl Acad Sci USA. 2007; 104(17):7217-7222.
38. Krishnaveni M, Kumar KM, Gopinath C. A review of beneficial role of lycopene in human body.IJAPR. 2012; 3(8):1033-1037.
39. Micozzi MS, Brown ED, Edwards BK et al. Plasma carotenoid response to chronic intake of selected foods and beta-carotene supplements in men. Am J Clin Nutr. 1992; 55(6):1120-1125.
40. Borek C. Antioxidants and cancer, science and medicine. The baby-boomer’s guide New Canaan connecticus keats publishing.1991; 4: 51-61.
41. Rodriguez-Amaya D. Food carotenoids: Analysis, composition and alterations during storage and processing of foods. Forum Nutr.2003.56: 35–37.
42. Xianquan S, Shi J, Kakuda Y, Yueming J. Stability of lycopene during food processing and storage. J Med. Food.2005; 8(4): 413–22.
43. Kensler TW, Wakabayashi N, Biswal S: Cell survival responses to environmental stresses via the Keap1-Nrf2-ARE pathway. Annu Rev Pharmacol Toxicol 2007; 47:89-116.
44. Jeong WS, Jun M, Kong AN: Nrf2: a potential molecular target for cancer chemoprevention by natural compounds. Antioxid Redox Signal. 2006; 8:99-106.
45. Baur JA, Pearson KJ, Price NL, Jamieson HA, Lerin C, Kalra A, Prabhu VV et al. Resveratrol improves health and survival of mice on a high-calorie diet. Nature 2006; 444:337-342.
46. Wood JG, Rogina B, Lavu S, Howitz K, Helfand SL, Tatar M, Sinclair D: Sirtuin activators mimic caloric restriction and delay ageing in metazoans. Nature 2004; 430:686-689.
47. Astley SB, Elliott RM, Archer DB, Southon S. Evidence that dietary supplementation with carotenoids and carotenoid-rich foods modulates the DNA damage: repair balance in human lymphocytes. Br J Nutr, 2004; 91:63-72