REFERENCES

Abuja, P. M., and Albertini, R. 2001. Methods for monitoring oxidative stress, lipid peroxidation and oxidation resistance of lipoproteins. International Journal of Clinical Chemistry 306: 1-17.

Aebi, H. 1984. Catalase in vitro. Methods in Enzymology 105: 121-126.

Anderson, M. E. 1985. Determination of glutathione and glutathione disulfild in biological samples. Methods in Enzymology 113: 548-555.

Anderson, S., Bankier, A., and Barrell, B. G. 1981. Sequence and organization of the human mitochondrial genome. Nature 290: 457-465.

Asakawa, T., and Matsushita, S. 1980. Coloring condition of thiobarbituric acid test for defecting lipid hydroperoxide. Lipids 15: 137-140.

Battisti, C., Formichi, P., Cardaiolo, E., Bianchi, S., and Mangiavacchi, P. 2004. Cell response to oxidative stress induced apoptosis in patients with Leber's hereditary optic neuropathy. Journal of Neurology Neurosurgery and Psychiatry 75: 1731-1736.

Bompart, G. J., Prevot, D. S., and bascands, J. L. 1990. Rapid automated analysis of glutathione reductase, peroxidase and S-transferase activity. Clinical of Biochemistry 23: 501-504.

Carelli, V., Crisneros, F. R., and Sadun, A. 2002. Optic nerve degeneration and mitochondrial dysfunction: genetic and acquired optic neuropathies. Neurochemistry International 40: 573-584.

Carelli, V., Rugolo, M., Sgarbi, G., Ghelli, A., Zanna, C., Baracca, A., Lenaz, G., Napoli, E., Martinuzzi, A., and Solaini, G. 2004. Bioenergetics shapes cellular death pathways in Leber's hereditary optic neuropathy: a model of mitochondrial neurodegeneration. Biochimica et Biophysica Acta 1658: 172-179.

Chalmers, R. M., and Schapira, A. H. 1999. Clinical, biochemical and molecular genetic features of Leber's hereditary optic neuropathy. Biochimica et Biophysica Acta 1410: 147-158.

Chan, M. M. Y., Huang, H. I., Fenton, M. R., and Fong, D. 1998. *In vivo* inhibition of nitric oxide synthase gene expression by curcumin, a cancer preventive natural product with anti-infammatory properties. Biochemical Pharmacology 55: 1955-1998.

Cheng, A. L., Hsu, C. H., Lin, J. K., Hsu, M. M., Ho, Y. F., Shen, T. S., Ko, J. Y., Lin, J. T., Lin, B. R., Wu, M. S., Yu, H. S., Jee, S. H., Chen, G. S., Chen, T. M., Chen, C. A., Lai, M. K., Pu, Y. S., Pan, M. H., Wang, Y. J., Tsai, C. C., and Hsieh, C. Y. 2001. Phase I clinical trial of curcumin, a chemopreventive agent, in patients with high-risk or pre-malignant lesions. Anticancer Research 21: 2895-2900.

Chinnery, P.F. 2005. Leber hereditary optic neuropathy (LHON). Gene Reviews. NIH [online]. A vailable from: http://www.genetests.org/servlet/acces.pdf. [2006, June 15].

Chuenkongkaew, W. L., Suphavilai, R., Vaeusorn, L., Phasukkijwatana, N., Lertrit, P. and Suktitipat, B. 2005. Proportion of 11778 mutant mitochondrial DNA and clinical expression in Thai population with Leber hereditary optic neuropathy. Journal of Neuro Ophthalmology. 25: 173-175.

Cortelli, P., Montagna, P., and Pierangeli, G. 1997. Clinical and brain bioenergetics improvement with idebenone in a patient with Leber's hereditary optic neuropathy: A clinical and P-MRS study. Journal of Neuroscience 148: 25-31.

Delalla, O. F., and Gofman, J. W. 1954. Utracentrifugal patterns of serum lipoproteins. Methods of Biochemical Analysis: 459-470.

Deng, S. L., Chen, W. F., Zhou, B., and Yang, L. 2006. Protective effect of curcumin and its analogues against free radical-induced oxidative haemolysis of human red blood cells. Food Chemistry 98: 112-119.

Drabkin, D. L., and Austin, J. H. 1935. The analysis of undiluted blood and concentrated hemoglobin solutions. Journal of Biological Chemistry 112: 105-115.

Floreani, M., Napoli, E., Martinuzzi, A., Patano, G., and Riva, V. D. 2005. Antioxidant defenses in cybrids haboring mtDNA mutations, associated with Leber's hereditary optic neuropathy. The Formerly European Journal of Biochemistry 272: 1124-1135.

Ghelli, A., Zanna, C., and Porcekku, A. M. 2003. Leber's hereditary optic neuropathy (LHON) pathogenic mutations induce mitochondrial-dependent apoptosis death in transmitochondrial cells incubated with galactose medium. Journal of Biological Chemistry 278: 4145-4150.

Griffith, O. W. 1980. Deternimation of glutathione and glutathione disulfide using glutathione reductase and 2-vinylpyridine. Analytical biochemistry 106: 207-212.

Grisham, M. B. 1992. Reactive Metabolites of Oxygen and Nitrogen in Biology and Medicine R. G. Landes Co., Austin, TX, pp. 104.

Halliwekk, B., and Gutteridge, J. M. C. 1999. Free Radicals in Biology and Medicine. 3rd edn. Oxford: Oxford Science Publications.

Heidi, L., Sophie, B., Roland, Z., Jean-Paul, T., Serge, L., and Didier, M. 2004. Effects of curcumin and curcumin derivatives on mitochondrial permeability transition pore. Free Radical Biology & medicine 36: 919-929.

Huoponen, K., Vilkki, J., Aula, P., Nikoskelainen, E. K., and Savontaus, M. L. 1991. A new mtDNA mutation associated with Leber's hereditary optic neuroretinopathy. American Journal of Human Genetics 48: 1147-1153.

Huoponen, K., Puomila, A., Savontaus, M. L., Mustonen, E., Kronqvist, E., and Nikoskelainen, E. 2002. Acta ophthalmologica Scandinavica 80: 38-43.

Iqbal, M., Okazaki, Y., and Okada, S. 2003. *In vitro* curcumin modulates ferric nitrilotriacetate (Fe-NTA) and hydrogen peroxide (H_2O_2)-induced peroxidation of microsomal membrane lipids and DNA damage. Teratogenesis, Carcinogenesis and Mutagenesis 23: 151-160.

Inano, H., Onoda, M., Infuku, N., Kubota, M., Kamada, Y., Osawa, T., Kobayashi, H., and Wakabayashi, K. 2000. Potent preventive action of curcumin on radiation-induced initiation of mammary tumorigenesis in rats. Carcinogenesis 21: 1835-1841.

Ireson, C. R., Jones, D. J. L., and Orr, S. 2002. Metabolism of the cancer chemopreventive agent curcumin in human and rat intestine. Cancer Epidemology Biomarker and Prevention 11: 97-104.

Izawa, S., Inoue, Y., and Kimura, A. 1996. Importance of catalase in the asaptive response to hydrogen peroxide: analysis of acatalasaemic Saccharomyces cerevisiae. Journal of Biochemistry 320: 61- 67.

Jayaprakasha, G. K., Mohan Rao, L. J. and Sakariah, K. K. 2005. Chemistry and biological activities of *C. longa.* Trends in Food Science of Technology 16: 533-548.

Janero, D. R., 1990 Malondialdehyde and thiobarbituric acid-reactivity as diagnostic indices of lipid peroxidation and peroxidative tissueinjury. Free Radical Biology and Medicine 9: 515-540.

Kang, H. C., Nan, J. X., Park, P. H., Kim, J. Y., Lee, S. H., Woo, S. W., Zhao, Y. Z., Park, E. J., and Sohn, D. H. 2002. Curcumin inhibits collagen synthesis and hepatic stellate cell activation *in-vivo* and *in-vitro*. Journal of Pharmacy and Pharmacology 54: 119-126.

Kudin, A. P., Bimpong-Buta, N. Y., Vielhaber, S., Elger, C. E., and Kunz, W. S. 2004. Characterization of superoxide-producing sites in isolated brain mitochondria. Journal of Biological Chemistry 279: 4127–4135.

Kobuyashi, Y., Okahata, S., Tanabe, K., and Usui, T. 1978. Use of logit paper in determination of superoxide dismutase activity in human blood cells. Journal of Immunological methods. 24: 75-78.

Lenaz, G., Baracca, A., Carelli, V., Aurelio, M. D., Sgarbi, G., and Solaini, G. 2004. Biochemica et Biophysica Acta 1656: 89-94.

Lee, H., Yin, P. H., Lu, C. Y., Chi, C. W., and Wei, Y. H. 2000. Increase of mitochondria and mitochondria DNA in response to oxidative stress in human cells. Biochemical Journal 2: 425-432.

Man, P. Y. W., Turnbull, D. M., and Chinnery, P. F. 2002. Leber's hereditary optic neuropathy. Journal of Medical Genetics 39: 162-169.

Masuda, T., Hidaka, K., Shinohara, A., Maekawa, T., Takeda, Y., and Yamaguchi, H. 1999. Chemical Studies on Antioxidant Mechanism of Curcuminoid: Analysis of Radical Reaction Products from Curcumin. A Journal of Agricultural and Food Chemistry 47: 71 -77.

Mashima, Y., Kigasawa, K., and Wakakura, M. 2000. Do idebenone and vitamin therapy shorten the time to achieve visual recovery in Leber's hereditary optic neuropathy. Journal of Neuro Ophthalmology 20: 166-170.

Mates, M. J., Segura, M. J., Cristina, P, G., and Francisca, M. 1999. Antioxidant enzymatic activities in human blood cells after an allergic reaction to pollen or house dust mite. Blood Cells, Molecules, and Diseases 15: 103-109

Meister, A., and Anderson, M. E. 1983. Glutathione. Annual review of biochemistry 52: 711-760.

Miquel, J., Bernd, A., Senpere, J. M., Diaz-Alperi, J., and Ramirez, A. 2002. The curcuma antioxidants: pharmacological effects and prospects for future clinical use. a review. Archive of Gerontology Geriatric 34: 37-46.

Miyazawa, T. 2001. Dietary curcuminoids prevent high-fat diet-induced lipid accumulation in rat liver and epididymal adipose tissue. Journal of Nutrition 131: 2932-2935.

Mondelli, M., Rossi, A., and Scarpini, C. 1991. Leber'soptic atrophy: VEP and BAEP changes in 16 asymptomatic subjects. Acta Neurologica Scandinavica 84:366-368.

Newman, N. J., Lott, M. T., and Wallace, D. C. 1991. The clinical characteristics of pedigrees of Leber's hereditary optic neuropathy with the 11778 mutation. American Journal of Ophthalmology 111: 750-762.

Newman, N. J. 1993. Leber's hereditary optic neuropathy. Archive of Neurology 50: 540-548.

Nikoskelainen, E. K. 1994. Clinical picture of LHON. Clinical Neuroscience 2: 115-120.

Oberley, L. W., and Spitz, D. R. 1984. Assay of superoxide dismutase activity in tumor tissue. Methods in Enzymology 105: 457-464.

Orssaud, C. 2003. Leber's hereditary optic neuropathy. Orphanet [online]. A vailable from: http://www. Orphan.net/data/patho/GB/uk-LHON.pdf.[2006, June 15].

Paglia, D. E., and Valentine, W. N. 1967. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. Journal of Laboratory and Clinical medicine 70: 158-167.

Paulus, W., Straube, A., and Bauer, W. 1991. Central nervous system involvement in Leber's hereditary optic neuropathy. Journal of Neurochemistry 240: 251-253.

Phasukkijwatana, N., Chuenkongkaew, W. L., Suphavilai, R., Suktitipat, B., Pingsuthiwong, S., Ruangvaravate, N., Atchaneeyasakul, L., Warrasak, S., Poonyathalang, A.,Sura, T., and Lertrit, P. 2006. The unique characteristics of Thai Leber hereditary optic neuropathy: analysis of 30 G11778A pedigrees. Journal of Human Genetics. 5: 298-304.

Praphaiphit Insain, "The antioxidant effect of curcumin in red blood cell of beta – thalassemia/HbE patients," (Master's Thesis, Graduate School, Mahidol university, 2004).

Pippenger, C. E., Browne, R. W., and Armstrong, D. 1998. Regulatory antioxidant Enzymes. Free Radical and Antioxidant Protocols 108: 299-313.

Pitkänen, S. and Robinson, B. H. 1996. Mitochondrial complex I deficiency leads to increased production of superoxide radicals and induction of superoxide dismutase. Journal of Clinical Investigation 98: 3485-3501.

Pulla Reddy, A. C. H., and Lokesh, B. R. 1994. Effect of dietary tumeric (*Curcuma longa*) on iron-induced lipid peroxidation in the rat liver. Food and Chemical Toxicology 32: 279-283.

Qi, X., Lewin, A. S., and Houswirth, W. W. 2003. Optic neuropathy induced by reduction in mitochondrial superoxide dismutase. Investigation Opthamology Visual Science 44: 1088-1096.

Riodan-eva, P., Sander, M. D., and Govan, G. G. 1995. The Clinical features of Leber's hereditary optic neuropathy defined by the presence of a pathogenic mitochondrial DNA mutation. Brain 118: 319-337.

Sela, S., Mazor, R. Amsalam, M., Yagil, C., Yagil, Y., and Kristal, B. 2004. Primed Polymorphonuclear Leukocytes, Oxidative Stress, and Inflammation Antecede Hypertension in the Sabra Rat. Hypertension 44:764-769.

Sharma, R. A., McLelland H. R., and Hill, K. A. 2001. Pharmacodinamic and pharmacokinetic study of oral Curcuma extract in patients with colorectal cancer. Clinical Cancer Research 7: 1894-1900.

Sharma, R. A., Gescher, A. J., and Steward, W. P. 2005. Curcumin: The story so far. European Journal of Cancer 41: 1955-1968.

Shoba, G., Joy, D., Joseph, T., Majeed, M., Rajendran, R., and Srinivas, P.S. 1998. Influence of piperine on the pharmacokinetics of curcumin in animals and human volunteers. Planta Medica 64: 353-356.

Smith, D. G., Cappai, R., and Barnham, K. J. 2007. The redox chemistry of the Alzheimer's disease amyloid β peptide. Biochimica et Biophysica Acta xx: xxx–xxx.

Smith, K. H., Johns, D. R., Heher, K. L., and Miller, N. R. 1993. Heteroplasmy in Leber's hereditary optic neuropathy. Archive of Ophthalmology 111: 1486-1490.

Sreejayan, R., and Rao, M. N. 1994. Curcuminoids as potent inhibitors of lipid peroxidation. Journal of Pharmacy and Pharmacology 46: 1013-1016.

Tietze, F. 1968. Enzymic Method for quantitative determination of nanogram amounts of total and oxidized glutathione. Analytical Biochemistry 27: 502-522.

Thomas, J. P., Maiorino, M., Ursini, F., and Girotti, A. W. 1990. Protective action of phospholipids hydroperoxide glutathione peroxidase against membrane-damaging lipid peroxidation; in situ reduction of phospholipids and cholesterol hydroperoxides. Journal of Biological Chemistry 265: 454-461.

Wong, A., Cavekuer, L., and Collins, H. E. 2002. Differentiation-specific effects of LHON mutations introduced into neuronal NT12 cells. Human Molecular Genetics 11: 431-438.

Wright, J. S. 2002. Predicting the antioxidant activity of curcumin and curcuminoids. Journal of Molecular Structure 59: 207-217.

Van Kuijik, F., Sevanian, A., Handelman, G. J., and Dratz E. A. 1987. A new role of phospholipase A2: protection of membranes from lipid peroxidation damage. The International Biometric Society 12: 31-34.

Volpe, N. J., and Lessel, S. 1993. Leber's hereditary optic neuropathy. International Ophthalmology Clinics 33: 153-168.

Wei, Q. Y., Chen, W. F., Zhou, B., Yang, L., and Liu, Z. L. 2006. Inhibition of lipid peroxidation and protein oxidation in rat liver mitochondria by curcumin and its analogues. Biochimica et Biophysica Acta 1760: 70-77.

Yang, F., Lim, G. P., Begaum, A. N., Ubeda O. J., Simmons, M. R., and Ambegaokar, S. S. 2005. Curcumin inhibits formation of amyloid beta oligomers and fibrils, binds plaques and reduces amyloid *in vivo*. Journal of Biological Chemistry 280: 5892-5901.

Yen, M. Y., Wang, A. G., and Wei, Y. H. 2006. Leber's hereditary optic neuropathy: a multifactorial disease. Progress in Retinal and Eye Research 25: 381-396.

Zbarsky, V., Datla, K. P., Parkar, S., Rai, D. K., Aruoma, O. I., and Dexter, D.T. 2005. Neuroprotective properties of the natural phenolic antioxidants curcumin and naringenin but not quercetin and fisetin in a 6-OHDA model of Parkinson's disease. Free Radical Research 39: 1119-1125.

Zeviani, M., and Di Donato, S. 2004. Mitochondrial disorders. Brain 127: 2153-2172.

APPENDICES

APPENDIX A

1. LHON characteristic

Placebo group = 0

Group	Sample No.	Age	W (kg)	H (cm)	Smoke	Alcohol	Other disease	Impair Liver function	HT
0	L1	18	60.0	174.0	1	1		0	0
0	L2	40	65.0	170.0	1	1		0	0
0	L4	21	70.0	165.0	1	1		0	0
0	L5	33	58.0	155.0	0	0		0	0
0	L9	18	71.0	180.0	1	1		0	0
0	L10	16	52.0	161.0	1	1		0	0
0	L12	21	65.0	177.0	1	1		0	0
0	L15	15	55.0	182.0	1	1		0	0
0	L18	23	60.0	173.0	0	0	Peptic ulcer	0	0
0	L21	49	54.0	162.0	0	0	Hemorrhoid	1	0
0	L23	35	58.5	166.0	1	1		0	0
0	L27	21	53.0	174.0	1	1		0	0
0	L32	52	61.8	152.2	1	1		0	1
0	L34	29	65.0	175.0	1	1		0	0
0	L35	49	62.0	159.0	0	0		0	0
				Yes	**11**	**11**		**1**	**1**
				No	**4**	**4**		**14**	**14**

Curcuminoid group = 1

1	L3	30	59.0	167.0	0	0		0	0
1	L6	22	55.0	166.0	0	1		0	0
1	L7	39	49.0	158.0	1	1		1	0
1	L8	52	50.0	155.0	0	0	Anemia	0	0
1	L11	12	38.0	147.0	0	0		0	0
1	L13	26	52.0	159.0	0	0		1	0
1	L16	56	49.9	152.0	1	1		0	0
1	L17	16	67.0	178.0	0	0		0	0
1	L19	40	60.0	170.0	1	1	Allergy	1	0
1	L20	23	50.0	172.0	0	0		1	0
1	L24	52	61.0	156.0	0	0	Hyperlipidemia	0	1
1	L25	21	65.0	175.0	0	0	Allergy	0	0
1	L26	24	67.0	157.0	1	0		1	0
1	L29	21	53.0	160.0	0	0		1	0
1	L30	23	45.0	159.0	0	0		1	0
1	L31	50	34.5	155.0	0	1		0	0
1	L36	67	58.0	157.0	0	0		0	0
				Yes	**4**	**5**		**7**	**1**
				No	**13**	**12**		**10**	**16**

2. The SGOT (AST) level in LHON patients (normal range = 0-37)

Placebo group = 0, ND = No data, * = higher than normal range.

Group	Sample No.	SGOT (AST) U/L		
		0M	3M	6M
0	L1	20.0	23.0	ND
0	L2	13.0	16.0	12.0
0	L4	14.0	22.0	ND
0	L5	33.0	24.0	ND
0	L9	27.0	23.0	ND
0	L10	22.0	18.0	ND
0	L12	17.0	26.0	ND
0	L15	16.0	16.0	ND
0	L18	31.0	ND	ND
0	L21	34.0	32.0	ND
0	L23	27.0	ND	ND
0	L27	13.0	ND	ND
0	L32	20.0	ND	ND
0	L34	19.0	18.0	ND
0	L35	22.0	ND	ND

Curcuminoid group = 1

1	L3	16.0	26.0	8.0
1	L6	13.0	21.0	11.0
1	L7	*157.0	12.0	ND
1	L8	29.0	27.0	19.0
1	L11	24.0	17.0	ND
1	L13	37.0	59.0	36.0
1	L16	20.0	36.0	ND
1	L17	14.0	11.0	ND
1	L19	*38.0	19.0	ND
1	L20	*55.0	48.0	26.0
1	L24	19.0	ND	ND
1	L25	11.0	ND	ND
1	L26	*44.0	34.0	ND
1	L29	*40.0	27.0	ND
1	L30	24.0	22.0	ND
1	L31	14.0	ND	ND
1	L36	18.0	ND	ND

3. The SGPT (ALT) level in LHON patients (normal range = 0-40)

Placebo group = 0, ND = No data, * = higher than normal range.

Group	Sample No.	SGPT (AST) U/L		
		0M	3M	6M
0	L1	20.0	30.0	ND
0	L2	15.0	11.0	12.0
0	L4	15.0	15.0	ND
0	L5	37.0	31.0	ND
0	L9	19.0	31.0	ND
0	L10	33.0	12.0	ND
0	L12	17.0	16.0	ND
0	L15	11.0	12.0	ND
0	L18	21.0	ND	ND
0	L21	*45.0	36.0	ND
0	L23	35.0	ND	ND
0	L27	15.0	ND	ND
0	L32	31.0	ND	ND
0	L34	17.0	15.0	ND
0	L35	18.0	ND	ND

Curcuminoid group = 1

1	L3	18.0	25.0	14.0
1	L6	8.0	6.0	3.0
1	L7	*56.0	16.0	ND
1	L8	19.0	19.0	17.0
1	L11	9.0	15.0	ND
1	L13	*63.0	49.0	39.0
1	L16	27.0	34.0	ND
1	L17	15.0	13.0	ND
1	L19	36.0	21.0	ND
1	L20	*46.0	25.0	27.0
1	L24	17.0	ND	ND
1	L25	19.0	ND	ND
1	L26	37.0	29.0	ND
1	L29	*48.0	36.0	ND
1	L30	*41.0	35.0	ND
1	L31	14.0	ND	ND
1	L36	17.0	ND	ND

4. The Malondialdehyde (MDA) level in LHON patients

Placebo group = 0, ND = No data

Group	Sample No.	MDA (nmole/ml)			
		0M	3M	6M	12M
0	L1	1.049	1.738	1.486	1.920
0	L2	1.510	1.442	1.688	1.825
0	L4	1.031	1.368	1.559	1.164
0	L5	1.150	1.627	1.683	1.847
0	L9	0.973	1.250	1.477	1.297
0	L10	1.076	1.152	1.140	1.304
0	L12	0.786	1.379	1.381	1.519
0	L15	0.755	0.901	1.012	1.320
0	L18	0.795	ND	1.538	1.931
0	L21	1.034	1.359	1.634	1.589
0	L23	1.502	1.244	1.389	1.634
0	L27	1.303	1.292	ND	1.398
0	L32	1.214	1.113	1.325	1.546
0	L34	1.120	0.930	1.000	1.412
0	L35	1.354	1.386	1.524	1.675
	Mean	**1.11**	**1.30**	**1.42**	**1.56**
	SE	**0.06**	**0.06**	**0.06**	**0.06**

Curcuminoid group = 1

1	L3	1.369	1.369	1.395	1.454
1	L6	1.452	1.452	1.494	1.550
1	L7	1.047	1.215	1.550	1.753
1	L8	0.987	1.441	1.899	2.012
1	L11	0.731	0.948	1.232	1.329
1	L13	1.003	1.332	1.860	1.795
1	L16	1.310	1.544	1.347	2.228
1	L17	1.260	1.260	1.071	1.598
1	L19	1.035	1.582	1.586	1.648
1	L20	0.813	1.036	1.010	1.323
1	L24	1.443	1.237	1.143	1.585
1	L25	1.767	1.385	1.427	1.675
1	L26	1.716	1.610	1.319	1.847
1	L29	1.580	1.290	1.315	1.539
1	L30	1.594	1.281	1.356	1.640
1	L31	1.523	1.183	1.345	1.725
1	L36	2.270	1.618	ND	1.432
	Mean	**1.35**	**1.34**	**1.40**	**1.65**
	SE	**0.09**	**0.05**	**0.06**	**0.06**

5. Catalase activity (KU/ g Hb)

Placebo group = 0, ND = No data

Group	Sample No.	CAT (KU/g Hb) 0M	3M	6M	12M
0	L1	5.09	5.21	4.67	5.26
0	L2	5.68	5.94	5.44	5.72
0	L4	5.37	6.18	5.27	5.88
0	L5	4.19	4.62	4.29	4.86
0	L9	3.34	5.11	5.48	5.56
0	L10	5.41	5.36	7.06	5.88
0	L12	4.85	4.30	4.77	5.65
0	L15	5.04	4.67	4.03	4.98
0	L18	4.42	ND	5.22	4.96
0	L21	4.73	5.32	5.82	6.18
0	L23	4.83	4.57	5.05	5.72
0	L27	4.54	5.44	ND	6.80
0	L32	4.94	5.60	5.58	5.71
0	L34	6.67	4.50	6.32	7.36
0	L35	5.38	6.10	6.29	5.92
	Mean	**4.96**	**5.21**	**5.38**	**5.76**
	SE.	**0.19**	**0.16**	**0.22**	**0.17**

Curcuminoid group = 1

1	L3	4.17	5.65	6.00	6.02
1	L6	4.96	5.03	4.19	5.06
1	L7	3.85	4.74	4.99	5.34
1	L8	4.86	4.56	4.61	4.73
1	L11	5.87	4.67	5.03	5.96
1	L13	4.76	5.14	5.21	5.62
1	L16	4.39	4.05	4.50	5.60
1	L17	4.88	4.74	4.97	5.52
1	L19	5.42	4.95	4.97	5.78
1	L20	5.63	5.28	4.95	6.58
1	L24	4.57	4.91	5.49	5.76
1	L25	4.57	5.52	6.38	5.78
1	L26	3.83	5.33	5.04	5.73
1	L29	4.22	5.45	5.59	6.38
1	L30	4.89	4.66	5.01	6.57
1	L31	6.74	5.64	5.07	6.19
1	L36	6.30	4.91	ND	6.14
	Mean	**4.93**	**5.01**	**5.13**	**5.81**
	SE.	**0.20**	**0.10**	**0.13**	**0.12**

6. Glutathione peroxidase activity (GPx)
Placebo group = 0, ND = No data

Group	Sample No.	GPx U/g Hb			
		0M	3M	6M	12M
0	L1	11.89	11.25	14.06	13.20
0	L2	14.43	15.78	13.81	12.05
0	L4	7.67	10.73	14.31	13.34
0	L5	13.80	17.24	17.15	17.15
0	L9	9.03	9.53	13.38	13.34
0	L10	13.96	13.48	19.70	17.64
0	L12	10.80	10.71	9.58	12.85
0	L15	8.98	7.42	14.53	10.39
0	L18	16.87	ND	8.58	9.93
0	L21	15.42	10.37	7.56	8.32
0	L23	13.50	10.93	11.30	10.93
0	L27	10.49	8.25	ND	9.62
0	L32	19.59	16.77	16.36	9.51
0	L34	5.09	5.25	5.79	6.20
0	L35	21.74	19.71	20.56	23.90
	Mean	**12.88**	**11.96**	**13.33**	**12.56**
	SE.	**1.15**	**1.10**	**1.17**	**1.13**

Curcuminoid group = 1

1	L3	17.73	8.83	13.83	15.62
1	L6	9.64	9.44	10.65	11.55
1	L7	13.58	10.52	10.91	18.96
1	L8	13.24	9.13	9.94	10.06
1	L11	12.05	9.93	11.52	11.86
1	L13	17.10	8.09	8.35	9.22
1	L16	13.84	10.14	15.08	12.60
1	L17	15.23	4.75	7.47	7.04
1	L19	14.41	12.84	15.02	12.78
1	L20	8.60	6.90	6.85	9.00
1	L24	8.56	3.95	9.82	8.91
1	L25	6.49	6.77	6.31	4.00
1	L26	12.60	9.80	8.00	7.62
1	L29	10.60	10.14	9.43	11.97
1	L30	11.13	7.58	11.86	9.77
1	L31	12.40	13.79	12.14	13.65
1	L36	18.19	16.27	ND	11.74
	Mean	**12.67**	**9.35**	**10.45**	**10.96**
	SE.	**0.80**	**0.74**	**0.68**	**0.84**

7. Superoxide dismutase activity (SOD)
Placebo group = 0, ND = No data

Group	Sample No.	SOD Unit/g Hb			
		0M	3M	6M	12M
0	L1	4271.77	3484.80	3290.96	4215.91
0	L2	5209.10	5190.96	3891.48	3325.48
0	L4	4655.23	5792.03	3936.82	3782.05
0	L5	3382.10	3540.66	3059.82	2516.72
0	L9	3415.24	4272.10	4312.54	3603.20
0	L10	4330.75	4772.37	5605.86	4062.68
0	L12	4539.81	2906.69	3838.29	5115.54
0	L15	4476.89	3164.56	4205.37	3325.38
0	L18	4201.59	ND	4828.25	3125.32
0	L21	3617.38	3778.12	3410.07	4758.56
0	L23	4039.62	2364.63	4158.72	4640.01
0	L27	4485.46	3203.71	ND	6329.89
0	L32	5232.83	6713.37	4843.57	6626.66
0	L34	4656.20	4789.14	5151.38	7798.03
0	L35	4975.19	6575.39	5333.46	6620.29
	Mean	**4365.94**	**4324.89**	**4276.18**	**4656.38**
	SE.	**148.55**	**364.40**	**209.05**	**399.50**

Curcuminoid group = 1

1	L3	4300.74	3974.91	3829.86	4246.58
1	L6	4716.52	3912.33	3033.90	3108.83
1	L7	4381.61	3541.48	3720.12	3735.40
1	L8	3428.71	2718.07	4046.29	3371.49
1	L11	5330.83	5502.98	4440.86	4664.03
1	L13	4350.08	4250.35	3998.18	5073.42
1	L16	4588.68	2434.76	3492.60	3606.94
1	L17	4549.21	3998.07	4605.87	3721.05
1	L19	4786.69	2896.19	3829.37	3373.15
1	L20	4364.86	3704.11	3985.63	4872.10
1	L24	4040.88	3201.61	4074.49	4053.43
1	L25	3929.51	3037.45	4662.30	4424.10
1	L26	3789.49	4400.09	4215.82	5405.58
1	L29	4659.96	3637.08	5212.37	5760.94
1	L30	4047.58	2602.67	3102.66	6163.62
1	L31	4828.80	5376.79	3890.31	6890.69
1	L36	2886.55	6092.14	ND	6289.59
	Mean	**4292.98**	**3840.06**	**4008.79**	**4633.00**
	SE.	**139.93**	**254.268**	**139.457**	**278.032**

8. Oxidized glutathione (GSSG)
Placebo group = 0, ND = No data

Group	Sample No.	GSSG(μmole/g Hb) 0M	3M	6M	12M
0	L1	0.13	0.17	0.16	0.21
0	L2	0.15	0.21	0.21	0.20
0	L4	0.15	0.17	0.17	0.17
0	L5	0.12	0.19	0.18	0.15
0	L9	0.11	0.16	0.19	0.11
0	L10	0.20	0.15	0.20	0.24
0	L12	0.13	0.15	0.18	0.14
0	L15	0.09	0.07	0.14	0.13
0	L18	0.13	ND	0.18	0.18
0	L21	0.08	0.09	0.21	0.12
0	L23	0.08	0.12	0.12	0.09
0	L27	0.12	0.13	ND	0.12
0	L32	0.15	0.18	0.22	0.20
0	L34	0.04	0.04	0.07	0.08
0	L35	0.16	0.17	0.17	0.20
	Mean	**0.12**	**0.14**	**0.17**	**0.16**
	SE.	**0.01**	**0.01**	**0.01**	**0.01**

Curcuminoid group = 1

1	L3	0.13	0.12	0.18	0.14
1	L6	0.14	0.19	0.19	0.21
1	L7	0.08	0.15	0.20	0.17
1	L8	0.10	0.10	0.11	0.11
1	L11	0.13	0.21	0.16	0.22
1	L13	0.09	0.10	0.09	0.08
1	L16	0.14	0.25	0.22	0.23
1	L17	0.13	0.21	0.17	0.19
1	L19	0.18	0.20	0.26	0.20
1	L20	0.18	0.08	0.08	0.16
1	L24	0.10	0.10	0.17	0.10
1	L25	0.09	0.14	0.14	0.13
1	L26	0.08	0.12	0.14	0.10
1	L29	0.15	0.19	0.13	0.26
1	L30	0.11	0.11	0.11	0.16
1	L31	0.15	0.13	0.14	0.17
1	L36	0.15	0.16	ND	0.14
	Mean	**0.13**	**0.15**	**0.16**	**0.16**
	SE.	**0.01**	**0.01**	**0.01**	**0.01**

9. Total glutathione (GSH)
Placebo group = 0, ND = No data

Group	Sample No.	GSH (µmole/g Hb) 0M	3M	6M	12M
0	L1	4.03	7.16	5.60	4.13
0	L2	5.53	6.36	5.22	3.84
0	L4	3.50	6.71	4.92	3.82
0	L5	3.80	6.08	4.78	4.06
0	L9	3.35	5.55	4.39	3.32
0	L10	3.47	7.01	7.52	5.45
0	L12	3.93	5.68	4.77	4.09
0	L15	3.65	5.76	4.40	4.27
0	L18	4.21	ND	4.44	4.35
0	L21	3.64	5.40	6.08	5.18
0	L23	4.31	4.89	4.59	6.10
0	L27	4.58	4.96	ND	5.56
0	L32	5.45	4.98	6.08	5.90
0	L34	6.66	10.24	11.89	9.97
0	L35	4.70	4.12	4.17	5.06
	Mean	**4.32**	**6.06**	**5.63**	**5.01**
	SE.	**0.24**	**0.40**	**0.54**	**0.42**

Curcuminoid group = 1

1	L3	4.07	6.81	4.57	3.19
1	L6	4.71	5.95	4.34	3.67
1	L7	3.70	6.50	6.93	4.59
1	L8	3.05	4.17	3.67	3.31
1	L11	5.03	5.51	5.17	5.08
1	L13	3.16	5.49	5.04	3.90
1	L16	3.64	6.67	5.44	5.01
1	L17	3.43	5.86	4.47	4.44
1	L19	4.04	5.38	6.61	5.35
1	L20	3.91	6.43	4.42	5.15
1	L24	4.70	5.33	4.70	5.35
1	L25	3.80	6.12	7.62	6.52
1	L26	4.04	5.45	6.55	4.68
1	L29	4.59	6.54	6.21	6.99
1	L30	5.46	5.58	5.37	5.50
1	L31	6.05	4.98	5.22	6.20
1	L36	4.32	4.10	ND	5.69
	Mean	**4.22**	**5.70**	**5.40**	**4.98**
	SE.	**0.19**	**0.19**	**0.27**	**0.26**

10. Hemoglobin in LHON patients.
Placebo group = 0, ND = No data

			Hb (mg/ml)			
Group	**Sample No.**	**Age**	**0M**	**3M**	**6M**	**12M**
0	L1	18	465.80	451.85	381.83	436.03
0	L2	40	434.93	458.39	412.26	471.14
0	L4	21	501.87	449.63	396.70	437.98
0	L5	33	616.06	488.66	437.53	435.33
0	L9	18	583.86	483.13	421.51	484.28
0	L12	21	432.32	457.15	440.72	513.76
0	L15	15	513.05	451.85	459.01	472.36
0	L18	23	530.38	ND	456.25	465.74
0	L21	49	564.95	459.89	341.62	510.53
0	L23	35	550.85	426.89	396.70	466.46
0	L27	21	505.18	448.77	ND	473.95
0	L32	52	524.10	433.18	402.04	454.14
0	L34	29	414.70	378.25	361.03	354.14
0	L35	49	411.03	417.52	420.38	414.51
Curcuminoid group = 1						
1	L3	30	495.96	461.11	395.35	494.28
1	L6	22	505.89	507.10	385.22	405.62
1	L7	39	566.61	472.23	400.20	485.48
1	L8	52	531.80	494.39	451.34	445.13
1	L11	12	484.14	403.57	374.83	381.60
1	L13	26	509.43	468.27	406.95	526.71
1	L16	56	635.75	426.32	378.82	411.33
1	L17	16	472.18	449.27	418.43	421.19
1	L19	40	483.05	469.71	340.58	420.62
1	L20	23	525.96	422.23	471.06	403.99
1	L24	52	521.56	442.45	400.26	442.77
1	L25	21	603.38	438.94	379.44	488.11
1	L26	24	562.04	458.60	397.74	539.75
1	L29	21	503.05	396.70	399.17	401.65
1	L30	23	477.38	490.15	405.22	433.89
1	L31	50	442.04	460	481.27	411.72
1	L36	67	437.58	477.53		448.99

APPENDIX B

1. Inter – run precision % cv of the assay for measure of MDA level in standard TEP and sample.

std MDA conc. (nmole/ml)	Intensity	Intensity	Intensity	Intensity	Intensity	mean	SD	% CV
0.20	83.85	76.43	60.93	80.32	74.39			
0.20	80.17	83.57	68.30	79.95	73.60	76.15	7.190	9.442
0.40	160.00	158.90	131.60	157.90	131.50			
0.40	151.40	143.70	135.10	163.90	143.20	147.72	12.354	8.363
0.80	278.30	293.60	277.40	319.90	287.70			
0.80	307.70	286.80	264.60	320.00	267.20	290.32	19.987	6.885
1.20	467.60	459.90	441.80	483.90	422.30			
1.20	477.20	459.90	411.30	481.30	417.80	452.30	27.266	6.028
1.60	620.70	566.70	571.70	655.50	535.80			
1.60	629.70	582.70	555.80	655.10	549.80	592.35	44.279	7.475

sample No.	1	2	3	4	5	mean	SD	% CV
N6	1.167	1.335	1.123	1.123	1.340	1.218	0.111	9.111
N7	0.989	1.04	1.085	0.897	1.12	1.0262	0.087	8.512
N8	0.762	0.724	0.745	0.787	0.779	0.759	0.026	3.366
N9	0.916	0.876	1.103	0.943	0.996	0.967	0.088	9.076
N10	3.208	3.344	3.769	3.232	3.453	3.401	0.228	6.691

2. Inter – run precision % cv of the assay for measure of SOD activity (unit/ml) of standard SOD and sample.

SOD conc.	1	2	3	4	5	mean	SD	%CV
2 unit	16.85	14.46	14.17	18.69	16.67			
2 unit	16.08	17.40	12.66	19.85	19.54	16.64	1.84	11.04
4 unit	51.03	39.11	25.03	51.05	40.69			
4 unit	47.84	37.80	24.63	50.23	39.41	40.68	7.49	18.40
6 unit	55.80	46.39	37.07	65.67	47.77			
6 unit	53.38	48.03	33.87	65.96	49.38	50.33	7.90	15.69
8 unit	54.76	56.30	53.13	68.13	57.43			
8 unit	58.04	55.34	50.40	67.36	56.49	57.74	4.06	7.04
10 unit	61.25	62.30	60.94	76.40	63.27			
10 unit	58.83	57.59	63.54	68.37	64.53	63.70	3.64	5.71
12 unit	65.88	67.55	72.66	74.92	69.54			
12 unit	64.88	64.60	71.35	71.97	68.83	69.22	2.87	4.15
14 unit	74.36	72.97	73.52	74.09	75.71			
14 unit	72.03	69.88	73.96	72.65	71.26	73.04	1.28	1.76

Sample	1	2	3	4	5	mean	SD	%CV
N6R	2137.44	2249.46	1769.48	2713.48	2882.28			
N6R	2271.74	2510.18	2397.20	2824.60	2511.72			
N6R	2490.62	2532.80	1959.06	3042.80	3186.92	2498.65	295.41	11.82
N7R	1789.16	1839.48	1881.36	2130.84	2168.88			
N7R	1943.54	2720.28	2220.60	1975.20	2606.54			
N7R	2576.94	2282.90	1327.84	2249.16	2288.66	2133.43	272.87	12.79
N8R	1478.28	3326.76	2021.54	2178.00	1811.98			
N8R	2332.44	2239.06	2063.20	2691.20	2382.14			
N8R	1899.06	2584.32	1810.88	3130.20	2398.60	2289.84	352.09	15.38

3. Inter – run precision % cv of the assay for measure of GPx activity (U/L) of sample.

sample No.	1	2	3	4	5	mean	SD	% CV
N1	6451.61	7258.06	7243.63	7153.23	7123.56	7046.02	337.21	4.79
N2	6935.48	7741.94	7586.32	7623.10	7583.25	7494.02	318.81	4.25
N3	6612.90	7903.23	6987.56	6789.56	6897.56	7038.16	503.32	7.15
N4	6129.03	6256.36	6158.56	6342.23	6256.87	6228.61	85.59	1.37

4. Inter – run precision % cv of the assay for measure of standard GSH (μM)

GSH μM	net rate1	net rate2	net rate3	net rate4	net rate5	mean	S.D	% cv
5.000	0.015	0.015	0.015	0.021	0.015	0.02	0.00	17.33
5.000	0.016	0.016	0.015	0.022	0.016	0.02	0.00	17.16
10.000	0.030	0.042	0.031	0.038	0.030	0.03	0.01	17.18
10.000	0.033	0.039	0.030	0.045	0.033	0.04	0.01	16.66
20.000	0.061	0.055	0.067	0.082	0.061	0.06	0.01	15.95
20.000	0.054	0.066	0.061	0.082	0.054	0.06	0.01	18.51
40.000	0.099	0.098	0.090	0.122	0.099	0.10	0.01	12.00
40.000	0.102	0.101	0.092	0.115	0.102	0.10	0.01	7.97
50.000	0.139	0.138	0.125	0.160	0.139	0.14	0.01	8.96
50.000	0.138	0.137	0.126	0.166	0.138	0.14	0.01	10.62
60.000	0.167	0.166	0.163	0.177	0.167	0.17	0.01	3.22
60.000	0.151	0.150	0.163	0.184	0.151	0.16	0.01	9.02

5. Inter – run precision % cv of the assay for measure of standard GSSH (μM)

GSSH μM	net rate1	net rate2	net rate3	net rate4	net rate5	mean	S.D	% cv
2.000	0.020	0.023	0.021	0.021	0.015			
2.000	0.019	0.023	0.021	0.022	0.016	0.020	0.003	13.755
4.000	0.038	0.047	0.039	0.038	0.042			
4.000	0.039	0.043	0.036	0.045	0.039	0.041	0.003	8.558
6.000	0.059	0.064	0.054	0.082	0.055			
6.000	0.066	0.064	0.054	0.082	0.066	0.065	0.010	16.142
8.000	0.085	0.079	0.069	0.122	0.098			
8.000	0.083	0.076	0.069	0.115	0.101	0.090	0.019	20.798
10.000	0.104	0.094	0.085	0.160	0.138			
10.000	0.094	0.099	0.091	0.166	0.137	0.117	0.030	25.991
12.000	0.119	0.118	0.105	0.177	0.166			
12.000	0.116	0.112	0.108	0.184	0.150	0.136	0.031	22.531

6. Inter – run precision % cv of the assay for measure of CAT (A240) in 3 min

	1	2	3	4	5			
sample No.	A240/3 min	A240/3 min	A240/3 min	A240/3 min	A240/3 min	mean	SD	% cv
N1	0.21	0.22	0.22	0.22	0.23			
N1	0.22	0.24	0.25	0.21	0.26	0.23	0.02	7.57
N2	0.23	0.24	0.23	0.23	0.23			
N2	0.25	0.24	0.28	0.22	0.25	0.24	0.02	7.21
N3	0.25	0.23	0.26	0.22	0.22			
N3	0.24	0.24	0.23	0.21	0.23	0.23	0.01	6.10
N4	0.20	0.23	0.25	0.22	0.25			
N4	0.23	0.25	0.24	0.23	0.23	0.23	0.02	6.82

BIOGRAPHY

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