# Mangosteen – Traditional and Modern Uses

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## Introduction – Traditional Use

Mangosteen (*Garcinia mangostana*) is a tropical fruit has been used as a traditional indigenous medicine across Southeast Asia (Thailand, Malaysia, Taiwan, Philippines, Indonesia, and Sri Lanka) for treatment of a wide range of ailments including fighting infections, healing wounds, and treating diarrhea and related gastrointestinal complaints. Mangosteen is known to contain a wide range of naturally-occurring polysaccharide and xanthone compounds within the fruit, leaves, heartwood, and especially the pericarp (rind/peel/hull) with widespread biological activities, including anti-inflammatory (Bennett 1989; Chomnawang 2005), antioxidant (Chiang 2003; Jung 2006), anti-proliferative (Ji 2006; Pedraza-Chaverri 2008), immunostimulatory (Matsumoto 2003), and antibacterial/antiviral effects in a number of experiments (Chanarat 1997; Pedraza-Chaverri 2008).

The pleasant taste (sweet and slightly acidic) and medicinal qualities of the reddish-purple mangosteen fruit has led to its common name as "Queen of Fruits" (Jung 2006). The demonstration of widespread biological effects of mangosteen-derived compounds, and especially of the family of bioactive xanthones (polyphenolic compounds, of which more than 1,000 have been described in nature, 18 isolated from mangosteen fruit, and 60 from the pericarp), suggest a scientific basis for the historical medicinal use of mangosteen preparations in Southeast Asian traditional medicine systems, including Ayurvedic medicine (Pedraza-Chaverri 2008). More "modern" health benefits of mangosteen preparations have been described in cases of arthritis (Pierce 2003), cancer (Ho, 2002), wounds (Mahabusarakam 1986; Wan 1973), inflammation (Saralamp 1996), ulcers (Harbone 1999), eczema (Morton 1987), acne (Chomnawang 2005), allergies (Nakatani 2002), and abdominal pain (Moongkarndi 2004), among many others (Pedraza-Chaverri 2008).

## Scientific Evidence

Extensive laboratory and human clinical research has suggested a strong link between the mechanisms by which oxidative stress leads to chronic inflammation, which in turn may mediate a wide array of chronic diseases of "aging" including cancer, obesity, diabetes, and diseases of the cardiovascular, pulmonary, and neurological systems (Reuter 2010). Oxidative stress is known to activate numerous inflammatory pathways and transcription factors, including those for growth factors, cytokines, and cell cycle regulatory molecules, which may lead to transformation of a normal cell to a tumor cell (Reuter 2010). Reducing inflammation in overweight and obese individuals may be valuable in preventing the progression to metabolic syndrome with associated risks for heart disease and diabetes (Udani 2009).

Inflammatory conditions are typically multi-factorial in their etiology. In obesity, for example, central adipose tissue is known to produce inflammatory cytokines including CRP and IL-6, which further influence insulin activity and glucose homeostasis (Rexrode 2003). Systemic chronic inflammation has emerged as a significant and specific predictor of cardiovascular disease, risk for myocardial infarction, and development of metabolic syndrome. Therefore the ability to reduce inflammation with mangosteen/xanthones may be an important and valuable preventive measure against the development of diabetes (Pradhan 2001 & 2003), heart disease (Pepys 2006; Ridker 2003; Tuomisto 2006; Willerson 2004), arthritis (Bradley 1992; Nicklas 2004; Reimold 2003), and inflammatory diseases of the lungs (Cazzola 2005; Martin 2002), digestive tract (Setoyama 2003), and skin (Breuer 2006; Groves 2004).

The pharmacological options for treating inflammation are numerous, including steroids and non-steroidal anti-inflammatory drugs (NSAIDs, such as aspirin, ibuprofen, and naproxen) – but their long-term use is associated with a range of potential adverse side effects including reduced resistance to infection and gastrointestinal bleeding (Caradoc-Davies 1984). As natural anti-inflammatory agents, mangosteen-derived xanthones, particularly alpha- and gamma-mangostins, are supported by a large body of scientific literature for their effects in various inflammatory pathways, including:

- Inhibition of both IgE-mediated histamine release and prostaglandin E2 synthesis from arachidonic acid as well as COX-2 activity in rat cancer cell lines (Chairungsrilerd 1996; Nakatani 2002a and 2002b).

- The major xanthone in mangosteen, alpha-mangostin, has shown antiplasmodial activity (Mahabusarakam 2006) and anti-larval activity (Ee 2006) in vitro.

- Various extracts of mangosteen (water, ethanol, ethyl acetate, methanol) have demonstrated antioxidant and neuroprotective activity in cell culture (Weecharangsan 2006).

- Antioxidant activity of mangosteen-derived xanthones has been demonstrated in direct free radical scavenging (Yoshikawa 1994), decreasing the oxidation of human low density lipoproteins (LDL) induced by peroxyl radical (Williams 1995), and prevention of alpha-tocopherol consumption during LDL oxidation (Mahabusarakam 2000). Such antioxidant effects have also been linked to neuroprotective activity (Weecharangsan 2006).

- Mangostin has shown antibacterial effects (in vitro) against staphylococcus aureus (Sakagami 2005; Voravuthikunchai 2005), Enterococci (Sakagami 2005), and Mycobacterium tuberculosis (Suksamrarn 2003) as well as a range of antibiotic-resistant strains of bacteria including methicillin-resistant S. Aureus (MRSA) and vancomycin resistant Entercocci (VRE) (Linuma 1996; Sakagami 2005).

- Chemopreventive effects of mangosteen extract have been demonstrated against rat colon carcinogenesis (Nabandith 2004) and against various human cell cultures of hepatic, lung, and gastric carcinomas (Ho 2002).

- In cell culture, alpha-mangostin induces apoptosis in a variety of human cancer cell lines (Matsumoto 2004a and 2004b; Moongkarndi 2004a), possibly due to antioxidant and/or anti-inflammatory activities (Moongkardndi 2004b).

- Direct anti-inflammatory activities of xanthones have been shown in rats challenged with the carrageenan-induced paw edema (Shankaranarayan 1979), and in cell cultures where both alpha- and gamma-mangostins inhibit histamine release (Chairungsrilerd 1996).

- Interestingly, a mouthwash containing mangosteen extract was found to reduce levels of volatile sulfur compounds associated with bad breath (Rassemeemasmaung 2007) and topical application of mangosteen xanthones has been shown to reduce acne (Chomnawang 2005; Saralamp 1996) and eczema (Morton 1987).

A recent human feeding trial evaluated the effects of a proprietary mangosteen (fruit plus pericarp) juice blend (Xango, Xango LLC) on markers of inflammation (highly-sensitive C-reactive protein, hs-CRP levels). The study was an 8 week randomized, double-blind, placebo-controlled design of 40 subjects that showed a significant change from baseline values (reduced CRP) in the subjects consuming mangosteen juice (Xango) compared to placebo (Udani 2009).

**Conclusions**

This brief overview of the traditional use and scientific evidence for mangosteen and mangosteen-derived xanthones demonstrates a long history of use of the fruit in traditional medicine systems around the world, as well as a detailed and extensive profile of the phytochemical constituents and pharmacological effects of the bioactive xanthone components that are richly and widely distributed in the mangosteen fruit and pericarp. The emerging clinical data suggests that whole mangosteen fruit preparations (fruit plus pericarp) containing a family of xanthone compounds may have important and considerable clinical potential in treating inflammation and a range of inflammatory conditions in human subjects. As such, the mangosteen is one of the few natural therapeutics from ancient traditional medicine systems that has stood the scrutiny of modern scientific evaluation. Further research should help elucidate and extend the health benefits of mangosteen to a wider population.

**References**


1. Asai F, Tosa H, Tanaka T, Iinuma M. 1995. A xanthone from peri-carps of Garcinia mangostana. Phytochemistry 39: 943–944.
2. Balunas MJ, Su B, Brueggemeier RW, Kinghorn AD. Xanthones from the botanical dietary supplement mangosteen (Garcinia mangostana) with aromatase inhibitory activity. J Nat Prod. 2008 Jul;71(7):1161-6. Epub 2008 Jun 18.
3. Bradley JD, Brandt KD, Katz BP, Kalasinski LA, Ryan SI: Treatment of knee osteoarthritis: relationship of clinical features of joint

inflammation to the response to a nonsteroidal antiinflammatory drug or pure analgesic. J Rheumatol 1992, 19:1950-1954.
4. Breuer K, Werfel T, Kapp A: Allergic manifestations of skin diseases--atopic dermatitis. Chem Immunol Allergy 2006, 91:76-86.
5. Caradoc-Davies TH: Nonsteroidal anti-inflammatory drugs, arthritis, and gastrointestinal bleeding in elderly in-patients. Age Ageing 1984, 13:295-298.
6. Cazzola M, Matera MG, Pezzuto G: Inflammation--a new therapeutic target in pneumonia. Respiration 2005, 72:117-126.
7. Chairungsrilerd N, Furukawa K, Ohta T, Nozoe S, Ohizumi Y. Histaminergic and serotonergic receptor blocking substances from the medicinal plant Garcinia mangostana. Planta Med. 1996 Oct;62(5):471-2.
8. Chanarat P, Chanarat N, Fujihara M, Nagumo T. Immunopharmacological activity of polysaccharide from the pericarp of mangosteen garcinia: phagocytic intracellular killing activities. J Med Assoc Thai. 1997 Sep;80 Suppl 1:S149-54.
9. Chanprechakul A. 2000. Antimutagenicity activity of Thai herbal beverages. In Research Reports. Thai Traditional Medicine and Future Prospective, Ministry of Public Health, Thailand; 109.
10. Chen LG, Yang LL, Wang CC. 2008. Anti-inflammatory activity of mangostins from Garcinia mangostana. Food Chem Toxicol 46: 688–693.
11. Chomnawang MT, Surassmo S, Nukoolkarn VS, Gritsanapan W. 2007. Effect of Garcinia mangostana on inflammation caused by Propionibacterium acnes. Fitoterapia 78: 401–408.
12. Chomnawang MT, Surassmo S, Nukoolkarn VS, Gritsanapan W. Antimicrobial effects of Thai medicinal plants against acne-inducing bacteria. J Ethnopharmacol. 2005 Oct 3;101(1-3):330-3.
13. Chomnawang MT, Surassmo S, Wongsariya K, Bunyapraphatsara N. Antibacterial activity of Thai medicinal plants against methicillin-resistant Staphylococcus aureus. Fitoterapia. 2009 Mar;80(2):102-4. Epub 2008 Nov 5.
14. Devi Sampath P, Vijayaraghavan K. Cardioprotective effect of alpha-mangostin, a xanthone derivative from mangosteen on tissue defense system against isoproterenol-induced myocardial infarction in rats. J Biochem Mol Toxicol. 2007;21(6):336-9.
15. Ee GC, Daud S, Izzaddin SA, Rahmani M. Garcinia mangostana: a source of potential anti-cancer lead compounds against CEM-SS cell line. J Asian Nat Prod Res. 2008 May-Jun;10(5-6):475-9.
16. Ee GC, Daud S, Taufiq-Yap YH, Ismail NH, Rahmani M. Xanthones from Garcinia mangostana (Guttiferae). Nat Prod Res. 2006 Oct;20(12):1067-73.
17. Farnsworth RN, Bunyapraphatsara N. 1992. Garcinia mangostana Linn. In Thai Medicinal Plants. Prachachon Co., Ltd.: Bangkok, 160–162.
18. Gales L, Damas AM. 2005. Xanthones – a structural perspective. Curr Med Chem 12: 2499–2515.
19. Gopalakrishnan C, Shankaranarayanan D, Kameswaran L, Nazimudeen SK. Effect of mangostin, a xanthone from

Garcinia mangostana Linn. in immunopathological & inflammatory reactions. Indian J Exp Biol. 1980 Aug;18(8):843-6.
20. Gopalakrishnan G, Banumathi B, Suresh G. 1997. Evaluation of the antifungal activity of natural xanthones from Garcinia mangostana and their synthetic derivatives. J Nat Prod 60: 519–524.
21. Gritsanapan W, Chulasiri M. 1983. A preliminary study of antidiarrheal plants and antibacterial activity. Mahidol Univ J Pharm Sci 10: 119–122.
22. Groves R: Cytokine and anti-cytokine therapy in the treatment of inflammatory skin disease. Cytokine 2004, 28:162-166.
23. Harrison NLJ. 2002. Xanthones from the heartwood of Garcinia mangostana. Phytochemistry 60: 541–548.
24. Ho CK, Huang YL, Chen CC. Garcinone E, a xanthone derivative, has potent cytotoxic effect against hepatocellular carcinoma cell lines. Planta Med. 2002 Nov;68(11):975-9.
25. Hung SH, Shen KH, Wu CH, Liu CL, Shih YW. Alpha-mangostin suppresses PC-3 human prostate carcinoma cell metastasis by inhibiting matrix metalloproteinase-2/9 and urokinase-plasminogen expression through the JNK signaling pathway. J Agric Food Chem. 2009 Feb 25;57(4):1291-8.
26. Iinuma M, Tosa H, Tanaka T, Asai F, Kobayashi Y, Shimano R, Miyauchi K. Antibacterial activity of xanthones from guttiferaeous plants against methicillin-resistant Staphylococcus aureus. J Pharm Pharmacol. 1996 Aug;48(8):861-5.
27. Ji X, Avula B, Khan IA. Quantitative and qualitative determination of six xanthones in Garcinia mangostana L. by LC-PDA and LC-ESI-MS. J Pharm Biomed Anal. 2007 Mar 12;43(4):1270-6. Epub 2006 Nov 28.
28. Jiang DJ, Dai Z, Li YJ: Pharmacological effects of xanthones as cardiovascular protective agents. Cardiovasc Drug Rev 2004, 22:91-102.
29. Jiang HZ, Quan XF, Tian WX, Hu JM, Wang PC, Huang SZ, Cheng ZQ, Liang WJ, Zhou J, Ma XF, Zhao YX. Fatty acid synthase inhibitors of phenolic constituents isolated from Garcinia mangostana. Bioorg Med Chem Lett. 2010 Aug 15.
30. Jung HA, Su BN, Keller WJ, Mehta RG, Kinghorn AD. Antioxidant xanthones from the pericarp of Garcinia mangostana (Mangosteen). J Agric Food Chem. 2006 Mar 22;54(6):2077-82.
31. Kikuchi H, Ohtsuki T, Koyano T, Kowithayakorn T, Sakai T, Ishibashi M. Activity of mangosteen xanthones and teleocidin a-2 in death receptor expression enhancement and tumor necrosis factor related apoptosis-inducing ligand assays. J Nat Prod. 2010 Mar 26;73(3):452-5.
32. Kondo M, Zhang L, Ji H, Kou Y, Ou B. Bioavailability and antioxidant effects of a xanthone-rich Mangosteen (Garcinia mangostana) product in humans. J Agric Food Chem. 2009 Oct 14;57(19):8788-92.
33. Loo AE, Huang D. Assay-guided fractionation study of alpha-amylase inhibitors from Garcinia mangostana pericarp. J Agric Food Chem. 2007 Nov 28;55(24):9805-10. Epub 2007 Oct 26.
34. Mahabusarakam W, Kuaha K, Wilairat P, Taylor WC. Prenylated xanthones as potential

antiplasmodial substances. Planta Med. 2006 Aug;72(10):912-6. Epub 2006 Aug 10.
35. Mahabusarakam W, Proudfoot J, Taylor W, Croft K. 2000. Inhibition of lipoprotein oxidation by prenylated xanthones derived from mangosteen. Free Radic Res 33: 643–659.
36. Mahabusarakam W, Wiriyachitra P. 1987. Chemical constituents of Garcinia mangostana. J Nat Prod 50: 474–478.
37. Malathi R, Kabaleeswaran V, Rajan SS. 2000. Structure of mangostin. J Chem Crystallogr 30: 203–205.
38. Marcason W. What are the facts and myths about mangosteen? J Am Diet Assoc. 2006 Jun;106(6):986.
39. Márquez-Valadez B, Lugo-Huitrón R, Valdivia-Cerda V, Miranda-Ramírez LR, Pérez-De La Cruz V, González-Cuahutencos O, Rivero-Cruz I, Mata R, Santamaría A, Pedraza-Chaverrí J. The natural xanthone alpha-mangostin reduces oxidative damage in rat brain tissue. Nutr Neurosci. 2009 Feb;12(1):35-42.
40. Martin RJ: Therapeutic significance of distal airway inflammation in asthma. J Allergy Clin Immunol 2002, 109:S447-S460.
41. Matsumoto K, Akao Y, Kobayashi E, Ohguchi K, Ito T, Tanaka T, Iinuma M, Nozawa Y. Induction of apoptosis by xanthones from mangosteen in human leukemia cell lines. J Nat Prod. 2003 Aug;66(8):1124-7.
42. Matsumoto K, Akao Y, Ohguchi K et al. 2005. Xanthones induce cell-cycle arrest and apoptosis in human colon cancer DLD- 1 cells. Bioorg Med Chem 13: 6064–6069.
43. Matsumoto K, Akao Y, Yi H, Ohguchi K, Ito T, Tanaka T, Kobayashi E, Iinuma M, Nozawa Y. Preferential target is mitochondria in alpha-mangostin-induced apoptosis in human leukemia HL60 cells. Bioorg Med Chem. 2004 Nov 15;12(22):5799-806.
44. Moongkarndi P, Kosem N, Kaslungka S, Luanratana O, Pongpan N, Neungton N. 2004a. Antiproliferation, antioxidation and in- duction of apoptosis by Garcinia mangostana (mangosteen) on SKBR3 human breast cancer cell line. J Ethnopharmacol 90: 161–166.
45. Moongkarndi P, Kosem N, Luanratana O, Jongsomboonkusol S, Pongpan N. 2004b. Antiproliferative activity of Thai medicinal plant extracts on human breast adenocarcinoma cell line. Fitoterapia 75: 375–377.
46. Nabandith V, Suzui M, Morioka T, Kaneshiro T, Kinjo T, Matsumoto K, Akao Y, Iinuma M, Yoshimi N. Inhibitory effects of crude alpha-mangostin, a xanthone derivative, on two different categories of colon preneoplastic lesions induced by 1, 2-dimethylhydrazine in the rat. Asian Pac J Cancer Prev. 2004 Oct-Dec;5(4):433-8.
47. Nakagawa Y, Iinuma M, Naoe T, Nozawa Y, Akao Y. Characterized mechanism of alpha-mangostin-induced cell death: caspase-independent apoptosis with release of endonuclease-G from mitochondria and increased miR-143 expression in human colorectal cancer DLD-1 cells. Bioorg Med Chem. 2007 Aug 15;15(16):5620-8. Epub 2007 May 18.
48. Nakatani K, Atsumi M, Arakawa T, Oosawa K, Shimura S, Nakahata N, et al.: Inhibitions of histamine release and prostaglandin E2 synthesis by mangosteen, a Thai

medicinal plant. Biol Pharm Bull 2002(b), 25:1137-1141. 30.
49. Nakatani K, Nakahata N, Arakawa T, Yasuda H, Ohizumi Y: Inhibition of cyclooxygenase and prostaglandin E2 synthesis by gamma-mangostin, a xanthone derivative in mangosteen, in C6 rat glioma cells. Biochem Pharmacol 2002(a), 63:73-79. 29.
50. Nakatani K, Yamakuni T, Kondo N, Arakawa T, Oosawa K, Shimura S, et al.: gamma-Mangostin inhibits inhibitor-kappaB kinase activity and decreases lipopolysaccharide-induced cyclooxy- genase-2 gene expression in C6 rat glioma cells. Mol Pharmacol 2004, 66:667-674.
51. Nguyen LH, Venkatraman G, Sim KY, Harrison LJ. Xanthones and benzophenones from Garcinia griffithii and Garcinia mangostana. Phytochemistry. 2005 Jul;66(14):1718-23.
52. Nicklas BJ, Ambrosius W, Messier SP, Miller GD, Penninx BW, Loeser RF, et al.: Diet-induced weight loss, exercise, and chronic inflammation in older, obese adults: a randomized control- led clinical trial. Am J Clin Nutr 2004, 79:544-551.
53. Nilar, Harrison LJ. Xanthones from the heartwood of Garcinia mangostana. Phytochemistry. 2002 Jul;60(5):541-8.
54. Pedraza-Chaverri J, Cárdenas-Rodríguez N, Orozco-Ibarra M, Pérez-Rojas JM. Medicinal properties of mangosteen (Garcinia mangostana). Food Chem Toxicol. 2008 Oct;46(10):3227-39. Epub 2008 Aug 6.
55. Pedraza-Chaverrí J, Reyes-Fermín LM, Nolasco-Amaya EG, Orozco-Ibarra M, Medina-Campos ON, González-Cuahutencos O, Rivero-Cruz I, Mata R. ROS scavenging capacity and neuroprotective effect of alpha-mangostin against 3-nitropropionic acid in cerebellar granule neurons. Exp Toxicol Pathol. 2009 Sep;61(5):491-501. Epub 2008 Dec 23.
56. Pepys MB, Hirschfield GM, Tennent GA, Gallimore JR, Kahan MC, Bellotti V, et al.: Targeting C-reactive protein for the treat- ment of cardiovascular disease. Nature 2006, 440:1217-1221.
57. Pongphasuk N, Khunkitti W, Chitcharoenthum M. 2005. Anti-inflammatory and analgesic activities of the extract from Garcinia mangostana Linn. Acta Hort (ISHS) 680: 125– 130.
58. Pothitirat W, Chomnawang MT, Supabphol R, Gritsanapan W. Comparison of bioactive compounds content, free radical scavenging and anti-acne inducing bacteria activities of extracts from the mangosteen fruit rind at two stages of maturity. Fitoterapia. 2009 Oct;80(7):442-7. Epub 2009 Jun 12.
59. Pradhan AD, Cook NR, Buring JE, Manson JE, Ridker PM: C-Reactive Protein is independently associated with fasting insulin in nondiabetic women. Arterioscler Thromb Vasc Biol 2003, 23:650-655.
60. Pradhan AD, Manson JE, Rifai N, Buring JE, Ridker PM: C-Reactive Protein, interleukin 6, and risk of developing type 2 diabetes mellitus. JAMA 2001, 286:327-334.
61. Rassameemasmaung S, Sirikulsathean A, Amornchat C, Hirunrat K, Rojanapanthu P, Gritsanapan W. Effects of herbal mouthwash containing the pericarp extract of Garcinia mangostana L on halitosis, plaque and papillary bleeding index. J Int Acad Periodontol. 2007 Jan;9(1):19-25.
62. Reimold AM: New indications for treatment of chronic inflammation

by TNF-alpha blockade. Am J Med Sci 2003, 325:75-92.
63. Reuter S, Gupta SC, Chaturvedi MM, Aggarwal BB. Oxidative stress, inflammation, and cancer: How are they linked? Free Radic Biol Med. 2010 Sep 11.
64. Rexrode KM, Pradhan AD, Manson JE, Buring JE, Ridker PM: Relationship of total and abdominal adiposity with CRP and IL-6 in Women. Ann Epidemiol 2003, 13:674-682.
65. Ridker PM, Buring JE, Cook NR, Rifai N: C-Reactive Protein, the metabolic syndrome, and risk of incident cardiovascular events: an 8-year follow-up of 14719 initially healthy Ameri- can women. Circulation 2003, 107:391-397.
66. Riscoe M, Kelly JX, Winter R. 2005. Xanthones as antimalarial agents: discovery, mode of action, and optimization. Curr Med Chem 12: 2539–2549.
67. Sakagami Y, Iinuma M, Piyasena KG, Dharmaratne HR. Antibacterial activity of alpha-mangostin against vancomycin resistant Enterococci (VRE) and synergism with antibiotics. Phytomedicine. 2005 Mar;12(3):203-8.
68. Sampath PD, Vijayaragavan K. Ameliorative prospective of alpha-mangostin, a xanthone derivative from Garcinia mangostana against beta-adrenergic cathecolamine-induced myocardial toxicity and anomalous cardiac TNF-alpha and COX-2 expressions in rats. Exp Toxicol Pathol. 2008 Aug;60(4-5):357-64. Epub 2008 Apr 18.
69. Sánchez-Pérez Y, Morales-Bárcenas R, García-Cuellar CM, López-Marure R, Calderon-Oliver M, Pedraza-Chaverri J, Chirino YI. The alpha-mangostin prevention on cisplatin-induced apoptotic death in LLC-PK1 cells is associated to an inhibition of ROS production and p53 induction. Chem Biol Interact. 2010 Oct 6;188(1):144-50.
70. Saralamp P, Temsiririrkkul R, Clayton T. 1996. Medical Plants in Thailand: Amarin Printing and Publishing Public Co., Ltd.: Bangkok, Thailand.
71. Sato A, Fujiwara H, Oku H, Ishiguro K, Ohizumi Y. 2004. Alpha-mangostin induces Ca2+-ATPase-dependent apoptosis via mitochondrial pathway in PC12 cells. J Pharmacol Sci 95: 33–40.
72. Sato A, Fujiwara H, Oku H, Ishiguro K, Ohizumi Y. Alpha-mangostin induces Ca2+-ATPase-dependent apoptosis via mitochondrial pathway in PC12 cells. J Pharmacol Sci. 2004 May;95(1):33-40.
73. Setoyama H, Imaoka A, Ishikawa H, Umesaki Y: Prevention of gut inflammation by Bifidobacterium in dextran sulfate-treated gnotobiotic mice associated with Bacteroides strains iso- lated from ulcerative colitis patients. Microbes Infect 2003, 5:115-122.
74. Shankaranarayan D, Gopalakrishnan C, Kameswaran L. Pharmacological profile of mangostin and its derivatives. Arch Int Pharmacodyn Ther. 1979 Jun;239(2):257-69.
75. Sintersmuk J, Deekijsermpong S. 1989. Effects of Garcinia mangostana peel extract on dysenteric bacteria and intesti- nal normal flora. Bull Dept Med Serv 14: 421–426.
76. Sornprasit A. 1987. Preliminary toxicological study of mangosteen. Songklanakarin J Sci Technol 9: 51–57.

77. Suksamrarn S, Suwannapoch N, Phakhodee W, Thanuhiranlert J, Ratananukul P, Chimnoi N, Suksamrarn A. Antimycobacterial activity of prenylated xanthones from the fruits of Garcinia mangostana. Chem Pharm Bull (Tokyo). 2003 Jul;51(7):857-9.
78. Sutabhaha B, Darntrakoon U, Furuya T, Nagumo T. 1997. The inhibitory activities of mangosteen's pericarp extract on methicillin-resistant Staphylococcus aureus. Bull Chiang Mai Assoc Med Sci 30: 40–46.
79. Tanaka R. Inhibitory effects of xanthone on paraquat- and NaNO(2)-induced genotoxicity in cultured cells. J Toxicol Sci. 2007 Dec;32(5):571-4.
80. Tang YP, Li PG, Kondo M, Ji HP, Kou Y, Ou B. Effect of a mangosteen dietary supplement on human immune function: a randomized, double-blind, placebo-controlled trial. J Med Food. 2009 Aug;12(4):755-63.
81. Toromanyan E, Aslanyan G, Amroyan E, Gabrielyan E, Panossian A. 2007. Efficacy of Slim339 in reducing body weight of overweight and obese human subjects. Phytother Res 21: 1177–1181.
82. Tuomisto K, Jousilahti P, Sundvall J, Pajunen P, Salomaa V: C-reactive protein, interleukin-6 and tumor necrosis factor alpha as predictors of incident coronary and cardiovascular events and total mortality. A population-based, prospective study. Thromb Haemost 2006, 95:511-518.
83. Udani JK, Singh BB, Barrett ML, and Singh VJ. Evaluation of Mangosteen juice blend on biomarkers of inflammation in obese subjects: a pilot, dose finding study. Nutrition Journal 2009, 8:48.
84. Vieira LMM, Kijjoa A. 2005. Naturally-occuring xanthones: recent developments. Curr Med Chem 12: 2413–2446.
85. Vlietinck AJ, Bruyne T, Apers S, Pieters LA. 1998. Plant-derived leading compounds for chemotherapy of human immuno-deficiency virus (HIV) infection. Planta Med 64: 97–109.
86. Walker EB. 2007. HPLC analysis of selected xanthones in mangosteen fruit. J Sep Sci 30: 1229–1234.
87. Weecharangsan W, Opanasopit P, Sukma M, Ngawhirunpat T, Sotanaphun U, Siripong P. Antioxidative and neuroprotective activities of extracts from the fruit hull of mangosteen (Garcinia mangostana Linn.). Med Princ Pract. 2006;15(4):281-7.
88. Willerson JT, Ridker PM: Inflammation as a cardiovascular risk factor. Circulation 2004, 109:II2-10.
89. Williams P, Ongsakul M, Proudfoot J, Croft K, Beilin L. 1995. Mangostin inhibits the oxidative modification of human low density lipoprotein. Free Radic Res 23: 175–184.
90. Yamakuni T, Aoki K, Nakatani K, Kondo N, Oku H, Ishiguro K, et al.: Garcinone B reduces prostaglandin E2 release and NF-kap- paB-mediated transcription in C6 rat glioma cells. Neurosci Lett 2006, 394(3):206-210.
91. Yu L, Zhao M, Yang B, Zhao Q, Jiang Y. 2007. Phenolics from hull of Garcinia mangostana fruit and their antioxidant activities. Food Chem 104: 176–181.