Evaluation of Cholesterol-lowering Activity of Standardized Extract of Mangifera indica in Albino Wistar Rats

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ABSTRACT

Introduction: Cholesterol lowering activity of Mangifera indica L. has been determined by earlier researchers and kernel, leaf and bark have shown significant activity. However, the specific cholesterol lowering activity of leaf methanol extract has not been determined. Materials and Methods: The present study involved evaluation of cholesterol lowering potential of methanol extract of M. indica leaves using high performance liquid chromatography. Results and Discussion: Significant cholesterol lowering activity was observed with methanol extract of M. indica leaves, at dose of 90 mg/kg body weight was also determined in female albino Wistar rats. Phytoconstituents Iriflophenone 3-C-β-D-glucoside and mangiferin were quantified in methanol extracts of different varieties of mango leaves using high performance liquid chromatography. Conclusions: The phytosterols rich extract of Mangifera indica leaves is a good source of nutraceutical ingredient that have the potential to lower serum cholesterol levels.

Key words: Hypercholesterolemia, Mangifera indica, mangiferin, mango leaves

SUMMARY

The Mangifera indica leaves methanolic extract showed significant cholesterol lowering activity in high cholesterol diet induced hypercholesterolemia model in rats when evaluated at a dose of 90 mg/kg rat body weight. The extract was found to contain Iriflophenone 3-C-β-D-glucoside and mangiferin which along with 3 β-taraxerol and other sterols could be contributing to the cholesterol lowering activity.

INTRODUCTION

High cholesterol is the 6th risk factor for death in the world.¹ Diets high in saturated fat, physical inactivity, and genetics can increase cholesterol levels. Cholesterol increases the risks of heart disease, stroke, and other vascular diseases. Globally, one-third of ischemic heart disease is attributable to high blood cholesterol. Hypercholesterolemia is the root cause for atherosclerosis and other cardiac complications. Individuals with elevated low-density lipoprotein (LDL) cholesterol are prone to the development of coronary heart disease through multiple stages of the process. Lowering of serum LDL cholesterol is the primary target of therapy. A number of clinical trials on cholesterol-lowering therapy using 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA) reductase inhibitors (statins [STs])² are published. STs are drugs of first choice in hypercholesterolemic patients, especially in those at high cardiovascular risk, some of them are intolerant to STs.³ Nutraceuticals are borderline devices between nutrients and drugs providing a supplementation of particular nutrients with beneficial effects on health. Nutraceuticals derived from plants have been suggested to improve plasma lipid profile.⁴ Extracts of gum ghatti of Anogeissus latifolia, Sida rhomboidea, soy protein, grape seeds, garlic, ginger, and citrus peel have been assessed for hypocholesterolemic activity.⁵ In particular, many herbal extracts are studied for controlling the cholesterol level. One such plant is Mangifera indica L. (Family: Anacardiaceae) commonly known as Mango, a large evergreen tree of tropical and subtropical region of India and other Asian countries.⁶ M. indica is one of the most famous of all tropical fruiting trees.⁷ There are more than thousand varieties of mango trees all over the world. Most parts of the tree (fruit, seed, pulp, stem bark, root, and leaves) have shown medicinal properties.⁸ In ayurvedic literature, different parts of this plant have been recommended as a remedy for various ailments. It is reported as antidiabetic,⁹ anti-oxidant,¹⁰ antiviral,¹¹ cardiotonic,¹² hypotensive,¹³ anti-inflammatory,¹⁴ antibacterial,¹⁵ antifungal,¹⁶ antihelminthic,¹⁷ antiparasitic,¹⁸ antitumor,¹⁹ anti-HIV,²⁰ anti-bone resorption,²¹ antispasmodic,²²
antipyretic,[27] anti-diarrheal,[28] anti-allergic,[29] immunomodulation,[30] hypolipidemic,[31] hepatoprotective,[32] and gastroprotective.[33] Phytochemical studies on various parts of *M. indica* L. revealed that it contains phenolic acids, phenolic esters, flavonols, etc., Mangiferin, a natural C-glucoside xanthone,[34] has been reported from various parts of *M. indica* and it had been studied for many pharmacological activities such as anti-diabetic, rheumatoid arthritis, anti-inflammatory, hypolipidemic, cardiotoxic, and antioxidant activities.[35–40] The leaves of *M. indica* have been studied for anti-diabetic properties using normoglycemic, glucose-induced hyperglycemia and streptozotocin-induced diabetic mice.[41] The aqueous extract of the leaves of *M. indica* has been reported to possess hypoglycemic activity.[42] Flavonoid-rich fraction of kernels of *M. indica*, leaf, and bark extract have shown anti-atherogenic activity and excretion of cholesterol through feces.[42] The ethanolic extract of immature leaf has been assessed for favorable hypolipidemic and hepatoprotective activities.[43] However, there is no report on the use of methanol extract of leaf for hypocholesterol activity. Hence, the present study involving the development of standardized methanol extract of *M. indica* leaf for hypercholesterolemia was undertaken. The oral toxicity study of leaf methanol extract at 5000 mg/kg body weight was also determined using female Wistar rats.

**MATERIALS AND METHODS**

**Chemicals**

Cholesterol AR and cholic acid were purchased from HiMedia Laboratories, Mumbai, India; ezetimibe tablet was from Lupin Ltd., Mumbai, India, and atorvastatin tablet from Ranbaxy Laboratories Ltd., Gurgaon, India; cholesterol estimation kits and triglycerides estimation kits were purchased from Bhat Bio-Tech India (P) Ltd., Bangalore, India.

**Plant material**

Fresh leaves of *M. indica* (Sindoora variety) were collected from Krishnagiri district, Tamil Nadu, India, and identified by Dr. P. Santhan, Taxonomist, Natural Remedies Pvt. Ltd, Bengaluru. A voucher specimen was deposited in the Agronomy Department of Natural Remedies Pvt. Ltd. The leaves were washed with water to remove mud and dusts. Further, the material was dried at room temperature, followed by hot air oven at not >40°C. The leaves were made into coarse powder for the extraction.

**Preparation of standardized methanol extract**

Leaves of Sindoora variety (5 kg) were extracted 3 times with methanol under the conditions of reflux for 3 h. The methanol extracts were filtered, combined, and concentrated at 60°C under vacuum using a rotary evaporator. The final powdered form of methanol extract was analyzed by high-performance liquid chromatography (HPLC) and used for hypocholesterol study.

**High-performance liquid chromatography**

**quantification of Iriflophenone3-C-β-D-glucoside and Mangiferin in the methanol extract**

The HPLC instrument consisted of Shimadzu SIL-10A Autoinjector, sample cooler, two CTO-10A pumps, CTO-10A column oven, SPD-M10A VP diode array detector, and SCL 10A VP central unit (Shimadzu Ltd, Kyoto, Japan). A purospher star Hibar* (250 mm × 4.6 mm, 5 μm, Merck, Darmstadt, Germany) was used. The gradient mobile phase consisted of water (solvent A) and acetonitrile (solvent B). The flow rate of the effluent was 1.5 ml/min, with run time of 52 min. Analysis was performed at room temperature using a gradient elution program: 0–5 min, 5–17% phase B; 5–10 min, 17–18% phase B; 10–15 min, 18–20% phase B; 15–20 min, 20–22% phase B; 20–25 min, 22–25% phase B; 25–30 min, 25–95% phase B; 30–34 min, 95–5% phase B; the detector wavelength was 280 nm and the volume of injection was 20 µL.

**Animals and diet for inducing hypercholesterolemia**

Male albino Wistar rats were divided into six groups. Six rats were randomly allotted to each group. Group I served as normal control. Group II was administered with groundnut oil (10 ml/kg) and Group III was treated with cholesterol at the dose of 500 mg/kg and cholic acid at the dose of 50 mg/kg in groundnut oil. Group IV was administered with ezetimibe at the dose of 0.9 mg/kg and Group V was treated with atorvastatin at 7.2 mg/kg rat body weight. Group VI was treated with the extract of *M. indica* at 90 mg/kg [Table 1]. Demineralized water was used as a vehicle for administration of reference standards and test substance. All the treatments were given daily by oral gavage for 42 days. Individual animal body weight was recorded at initiation of the study and mean group body weights were calculated thereafter weekly, until the end of the experiment. Plasma levels of cholesterol and triglycerides were estimated at weekly intervals, till the end of the study period.

**Acute toxicity study**

Acute oral toxicity test was performed as per OECD-423 guidelines. Healthy adult female rats, acclimatized to laboratory conditions for 1 week before dosing, were used in this study. Animals were randomly assigned to the cages, and the individual animal was fur marked with picric acid. The females were nulliparous and not pregnant. The rats were deprived of feed overnight before and 3 h after the administration of the test substance. Water was not withheld during this period. The test substance, solubilized in demineralized water, was administered by gavage to rats for 14 days using an intubation needle of appropriate size fitted into a syringe.[43]

**Biochemical estimations**

**Total cholesterol**

Serum total cholesterol was estimated by cholesterol oxidase-phenol amino antipyrine method using commercial kit.

**Statistical analysis**

The data were analyzed using one-way ANOVA followed by Bonferroni method as *post hoc* test. In case of heterogeneous data, after transformation

### Table 1: Study design

| Group | Treatment | Dose (rat body weight) |
|-------|-----------|------------------------|
| I     | Normal control |                        |
| II    | Vehicle control (groundnut oil) | 10 (ml/kg) |
| III   | Cholesterol control (cholesterol and cholic acid) | 500 and 50 (mg/kg) |
| IV    | Ezetimibe | 0.9 (mg/kg) |
| V     | Atorvastatin | 7.2 (mg/kg) |
| VI    | Mangifera indica extract | 90 (mg/kg) |

### Table 2: Details of amount of iriflophenone 3-C-β-D-glucoside and mangiferin in different varieties of mango leaves

| Mangifera indica varieties | Mangiferin (% w/w) | Iriflophenone 3-C-β-D-glucoside (% w/w) |
|----------------------------|--------------------|----------------------------------------|
| Sannabejjadakayi           | 4.2                | 2.8                                    |
| Sindoora                   | 4.5                | 2.7                                    |
| Malgova                    | 4.6                | 2.8                                    |
| Totapuri                   | 3.9                | 1.2                                    |
Dunnett T3 method was used. All values were reported as mean ± standard error of mean. The statistical significance was set at \( P < 0.05 \).

Mangiferin and iriflophenone-3-C-β-glucoside quantified in leaf methanol extract by HPLC [Figure 1] in different varieties of mango were found to be ranging 3.9–4.6% w/w and 1.2–2.8% w/w, respectively [Table 2]. The content of 3β-taraxerol was also measured using previously described method[34] and was found to be 0.40–0.49% w/w.

The mean body weight of experimental rats at weekly intervals is represented in Figure 2. On day 0, no significant difference in body weight was observed in all the groups. There was no significant difference in body weight observed in cholesterol control rats when compared to vehicle control rats on different weekly time intervals of the study period.

The mean plasma cholesterol levels at weekly intervals are presented in Table 3 and Figure 3. The plasma cholesterol was significantly increased in cholesterol control from day 21 to day 42 with a nonsignificant increase observed during day 7 to day 14 when compared to vehicle control. A significant decrease in plasma cholesterol was observed on treatment with an extract of \( M. \) indica and all other substances from day 21 to day 42 as compared to cholesterol control rats.

The mean plasma triglycerides levels at different time intervals are presented in Table 4 and Figure 4. The plasma triglyceride was significantly increased in cholesterol control rats from day 21 to day 42 as compared to vehicle control rats. A significant decrease in plasma triglycerides was observed on treatment with an extract of \( M. \) indica and all other substances from day 21 to day 42 as compared to cholesterol control rats.

Observations of clinical signs were made at 10 min, 30 min, 1 h, 2 h, 4 h, and 6 h after dosing on day 0 and once daily thereafter for 14 days at approximately same time. Cage-side observations included changes in the skin, fur, eyes, and behavior.
and mucous membrane. It also included respiratory, circulatory, autonomic and central nervous system, and somato motor activity and behavioral pattern. Particular attention was directed to the observation of tremors, convulsion, salivation, diarrhea, lethargy, sleep, and coma.

In acute oral toxicity studies, the test animals did not show any significant physical changes and behavioral patterns. There was no mortality even after 14 days observation, and there were no abnormalities found in the organs after the sacrifice of animals when compared to the control at the end of 14 days of general observation [Table 5].

**DISCUSSION**

*M. indica* has been reported to possess antidiabetic and hypolipidemic activities.[41,42,44] Phytochemical analysis of *M. indica* has shown the presence of many bioactive compounds such as flavonoids and phenolics. In our previous study, identification of bioactive compounds through BAGF, we have reported that ethyl acetate fraction of *M. indica* leaf methanolic extract has comparatively higher potency in cholesterol esterase inhibition assay, and further fractionation of this extract yielded 3β-taraxerol enriched fraction, which inhibited cholesterol esterase *in vitro* with an IC$_{50}$ of 0.86 µg/ml.[45] In the present *in vivo* study, the leaf methanol extract of *M. indica* has shown a significant reduction in serum cholesterol level in albino Wistar rats. The dose of 90 mg/kg body weight was chosen to consider the human dose of 1.0 g/day. This single dose study has shown reduction of 14% serum cholesterol level compared to 17% and 63% reduction caused by atorvastatin and ezetimibe, respectively.

In case of triglycerides, the reduction due to extract was 31% compared to 50% and 31% reduction caused by atorvastatin and ezetimibe, respectively.

### Table 3: Effect of extract of *Mangifera indica* on plasma cholesterol in albino Wistar rats

| Treatment groups | Plasma cholesterol (mg/dl) |
|------------------|---------------------------|
|                  | Day 7 | Day 14 | Day 21 | Day 28 | Day 35 | Day 42 |
| I                | 50.52±3.04 | 58.83±2.84 | 54.86±2.96 | 50.93±2.48 | 45.74±5.13 | 59.69±6.40 |
| II               | 53.32±3.80 | 53.48±3.49 | 53.02±4.79 | 52.04±4.43 | 51.06±5.03 | 54.19±6.53 |
| III              | 61.74±3.79 | 74.00±11.52 | 111.52±8.35* | 121.17±12.12* | 149.22±2.04* | 154.63±13.04* |
| IV               | 45.65±4.00 | 49.55±3.05 | 41.46±3.11* | 44.21±2.91* | 37.52±3.84* | 36.70±2.42* |
| V                | 46.67±0.99 | 51.02±3.53 | 46.15±6.25* | 48.56±4.27* | 60.64±3.97* | 50.67±7.18* |
| VI               | 51.59±5.66 | 57.22±6.46 | 50.36±5.61* | 55.73±3.41* | 54.86±6.38* | 51.11±7.26* |

Values are expressed as mean±SEM; *n* = 6. *P*≤0.05 vehicle control versus cholesterol control; *P*≤0.05 cholesterol control versus treated groups. SEM: Standard error of mean

### Table 4: Effect of extract of *Mangifera indica* on plasma triglycerides in albino Wistar rats

| Treatment groups | Plasma triglycerides (mg/dl) |
|------------------|-------------------------------|
|                  | Day 7 | Day 14 | Day 21 | Day 28 | Day 35 | Day 42 |
| I                | 90.46±9.52 | 81.70±10.32 | 82.55±5.42 | 96.08±9.34 | 91.96±8.27 | 82.35±9.49 |
| II               | 84.44±11.09 | 93.35±7.03 | 80.12±16.61 | 73.00±7.21 | 88.58±10.78 | 100.61±6.71 |
| III              | 100.47±15.35 | 141.76±17.51 | 236.30±18.49* | 241.71±19.50* | 283.76±32.38* | 212.08±21.55* |
| IV               | 82.82±16.77 | 72.78±13.00# | 88.12±14.28* | 96.36±17.24* | 80.44±14.41* | 66.70±11.07* |
| V                | 77.75±13.80 | 94.50±14.74 | 102.80±18.06* | 80.68±15.93* | 95.96±14.36* | 94.59±8.69* |
| VI               | 98.39±12.63 | 101.68±12.48 | 114.36±13.56* | 110.85±12.5* | 109.96±12.60* | 78.46±11.09* |

Values are expressed as mean±SEM; *n* = 6. *P*≤0.05 vehicle control versus cholesterol control; *P*≤0.05 cholesterol control versus treated groups. SEM: Standard error of mean

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**Figure 3:** Effect of extract of *Mangifera indica* leaves on serum total cholesterol level in albino Wistar rats

![Graph showing effect of extract on serum total cholesterol](image)

Values are expressed as mean ± SEM, *n* = 6. *p < 0.05 Normal / Vehicle control Vs Hypercholesterolemic control. *p < 0.05, Treated groups Vs Hypercholesterolemic control.
Table 5: Effect of extract of *Mangifera indica* on mortality of albino Wistar rats in acute oral study

| Group | Dose (mg/kg) | Animal ID | Observed signs | Period of signs in days from-to | Mortality |
|-------|--------------|-----------|----------------|-------------------------------|-----------|
| 1     | 5000         | 3FB       | Nil            | 0-14                          | Absolute 0, Relative % 0 |
|       |              | 4FT       | Nil            | 0-14                          | 0         |
|       |              | 5FW       | Nil            | 0-14                          | 0         |
|       |              | 6FHB      | Nil            | 0-14                          | 0         |

CONCLUSION

The methanol extract of *M. indica* showed a significant cholesterol-lowering activity at 90 mg/kg from day 21 to day 42 of 6 weeks treatment period, and a significant decrease in plasma triglycerides was also observed on treatment with extract. The 3β-taraxerol, mangiferin, and iriflophenone-3-C-β-glucoside quantified in leaf methanol extract by HPLC and were found to be 0.49% w/w, 4.6% w/w, and 2.37% w/w, respectively. The methanol extract of *M. indica* leaf was found to be safe after oral administration of single dose of 5000 mg/kg body weight to female albino Wistar rats.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Available from: [http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_part_2.pdf](http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_part_2.pdf) (Last accessed on 2015 Jan 10).
2. Cleeman JI. Executive summary of the third report of the National Cholesterol...
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Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA 2001;285:2486-97.

3. Pisciotto L, Bellocchio A, Bertolini S. Nutraceutical pill containing berberine versus ezetimibe on plasma lipid pattern in hypercholesterolemic subjects and its additive effect in patients with familial hypercholesterolemia on stable cholesterol-lowering treatment. Lipids Health Dis 2012;11:123.

4. Mannantri MR, Ministrini S, Pirro M. Nutraceuticals for the treatment of hypercholesterolemia. Eur J Intern Med 2014;25:592-9.

5. Parvathi KM, Ramesh CK, Krishna V, Paramesha M, Kuppast U. Hypolipidemic activity of gum ghatti of Anogeissus latifolia. Pharmacogn Mag 2009;5:5:11.

6. Devkar RV, Ramachandran AV, Patel DK, Patel KA, Patel UK, Thounaojam MC, et al. Assessment of lipid lowering effect of Sida rhomboides. Robj methanolic extract in experimentally induced hyperlipidemia. J Young Pharm 2009;1:233.

7. Zhong F, Liu J, Ma J, Shoemaker CF. Preparation of hypocholesterolemic peptides from soy protein and their hypocholesterolemic effect in mice. Food Res Int 2007;40:661-7.

8. Yamakoshi J, Kataoka S, Koga T, Ariga T. Proanthocyanidin-rich extract from grape seeds attenuates the development of aortic atherosclerosis in cholesterol-fed rabbits. Atherosclerosis 1999;142:139-49.

9. Yeh YY, Liu L. Cholesterol-lowering effect of garlic extracts and organosulfur compounds. Human and animal studies. J Nutr 2001;131:989S-93S.

10. Bhandari U, Sharma JN, Zafar R. The protectice action of ethanolic ginger (Zingiber officinale) extract in cholesterol fed rabbits. J Ethnopharmacol 1998;61:167-71.

11. Bok SH, Lee SH, Park YB, Bae KH, Son KH, Jeong TS, et al. Plasma and hepatic cholesterol and hepatic activities of 3-hydroxy-3-methyl-glutaryl-CoA reductase and acyl CoA: cholesterol acyltransferase are lower in rats fed citrus peel extract or a mixture of citrus bioflavonoids. J Nutr 1999;129:1182-5.

12. Khare CP. An encyclopedia of medicinal plants of India. Heidelberg, Germany: Springer-Verlag, 2004. p. 151.

13. Shah KA, Patel MB, Patel RJ, Parmar PK. Mangifera indica (mango). Pharmacogn Rev 2010;4:42-8.

14. Sharma PC. In: Database on Medicinal Plants Used in Ayurveda. Vol. 2. Central Council for Research in Ayurveda & Sidha, New Delhi; 2004. p. 8-28.

15. Aderibigbe AO, Emudanagheus TG, Lawal BA. Evaluation of the anti-diabetic action of Mangifera indica L. leaves. J Ethnopharmacol 2001;1:549-66.

16. Sultana B, Hussain Z, Asif M, Munir A. Investigation on the antioxidant activity of leaves, peels, stems bark, and kernel of mango (Mangifera indica L.). J Food Sci 2012;77:6:2849-52.

17. Zhu XM, Song JX, Huang ZZ, Wu YM, Yu MJ. Antiviral activity of mangiferin against herpes simplex virus type 2 in vitro. Zhongguo Yao Li Xue Bao 1993;14:452-4.

18. Prabhu S, Jainu M, Sabitha KE, Devi CS. A study on the beneficial effect of mangiferin on isoproterenol induced myocardial infarction in rats. Indian J Exp Biol 2006;44:209-15.

19. Muruganandan S, Gupta S, Kataria M, Lal J, Gupta PK. Mangiferin protects the heart from oxidative damage in streptozotocin-induced type 1 and type 2 diabetic model rats. J AGRIC Food Chem 2009;57:7712-8.

20. Leiro J, Arranz JA, Yáñez M, Ubeira FM, Sammartin ML, Orallo J. Expression profiles of genes involved in the mouse nuclear factor-kappa B signal transduction pathway are modulated by mangiferin. Int Immunopharmacol 2004;4:783-78.

21. Dineshkumar B, Mitra A, Manjunatha M. Studies on the anti-diabetic and hypolipidemic potentials of mangiferin (Xanthone Glucoside) in streptozotocin-induced type 1 and type 2 diabetic rat models. J Agric Pharm Sci 2010;1:75-85.

22. Sato T, Kawamoto A, Tamura A, Tatsumi Y, Fuji T. Mechanism of antioxidant action of pueraria glycoside (PG)-1 (an isoflavonoid) and mangiferin (a xanthone) in the rat liver. J Sci Food Agric 2009;60:9-27.

23. Bhowmik A, Khan LA, Akhter M, Rokeya B. Studies on the anti-diabetic and cardioprotective effect of Mangifera indica L. extract (Vimang) and contribution of active constituents. J Ethnopharmacol 2003;81:139-90.

24. Carvalho AC, Lima J, Costa HB, Silva Neto S, Costa AS, Ferreira P, et al. Antioxidant effects of flavonoids and their role in the prevention of diabetes and its complications. J J Pharm Pharmacol 2004;56:513-20.

25. Hossain MS, Ahmed M, Islam A. Hypolipidemic and hepatoprotective effects of different fractions of ethanolic extract of immature leaves of Mangifera indica (Linn.) in alloxan induced diabetic rats. JPSR 2010;1:132.

26. Engels C, Knödler M, Zhao YY, Carle R, Gänzle MG, Schieber A. Antimicrobial activity of gallotannins isolated from mango (Mangifera indica L.) kernels. J Agric Food Chem 2009;57:7712-8.

27. Carvalho AC, Guedes MM, de Souza AL, Trevisan MT, Lima AF, Santos FA, et al. Gastroprotective effect of mangiferin, a xanthone from Mangifera indica, against gastric injury induced by ethanol and indomethacin in rodents. Planta Med 2007;73:1372-6.

28. Ichiki H, Miura T, Kubo M, Ishihara E, Komatsu Y, Tanigawa K, et al. New anti-diabetic compounds, mangiferin and its glucoside. Bio Pharm Bull 1998;21:1389-90.

29. Linczkwicz P, Kokotkiewicz A, Dampc A, Linczkiewicz M. Mangifera indica: A promising therapeutic agent for rheumatoid arthritis treatment. Med Hypotheses 2014;83:570-4.

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32. Zhong F, Liu J, Ma J, Shoemaker CF. Preparation of hypocholesterolemic peptides from soy protein and their hypocholesterolemic effect in mice. Food Res Int 2007;40:661-7.