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MIRACULOUS MANGO SEED

RUKSHANA IRANI

Assistant Professor, Department of Food & Nutrition, Raidighi College, University of Calcutta, West Bengal, India

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Abstract: Mango ("*Mangifera indica* Linn.") is an extremely popular fruit which is known for its tempting taste and flavour around the globe. Several food industries produce different products of mango which results in generation of large quantity of seeds as by product which are disposed as waste. Scientific studies and ethno medicinal claims suggest that mango seeds possess broad spectrum of therapeutic and biological significance. It has been attributed to play remarkable role by virtue of its nutritional, antioxidant, antimutagenic, hypoglycaemic, antihyperlipidemic, hepatoprotective, antimicrobial, anti-inflammatory, antidiarrhoeal properties. These phenomenal potentials are due to the presence of many chemical constituents like macronutrients, micronutrients, polyphenols, phytosterols, fattyacids etc. It can be recognized as an easily accessible and cheap source of natural antioxidants and nutraceuticals. It is nature's wonderful gift and thus can be utilised as low cost antioxidant dietary supplements, medicines, bio preservatives and pharmaceuticals.

Keywords: Mango, Seed, Antioxidant, Therapeutic, Waste, Nutraceutical, Biopreservatives.

Corresponding Author: MS. RUKSHANA IRANI

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INTRODUCTION

Mango (*Mangifera indica L.)* is the king among tropical fruits and is greatly relished for its succulence, exotic flavour and delicious taste in most countries of the world[1]. It is an edible fruit and is one of the main agricultural products in many tropical regions. Mango varieties differ in not only fruit shape but also aroma, which is an important characteristic[2].Ripe mangoes are processed into frozen mango products, canned products, dehydrated products and ready-to-serve beverages[3].The mango juice industry uses only the edible portions of the mangoes, and a considerable amount of peels and seeds are discarded as industrial waste[4].During the processing of ripe mango, the waste (peel and seed) is a problem for canning factories. Its disposal may appreciably increase environmental pollution due to its rapid decay, thus becoming a good source of house fly multiplication[5].

The large amount of waste produced by the food industries cause serious environmental problems and also results in economic losses if not utilized effectively. Different research reports have revealed that food industry by-products can be good sources of potentially valuablebioactivecompounds[4].The disposal of mango bio waste is a growing problem due toincreasing production of this material (estimated to be around 75000 million Tons worldwide). From an environmental perspective, it is vital to reuse the plant by products produced by the agro-food industry[6, 7, 8].

Mango seed is a single flat oblong seed that can be fibrous or hairy on the surface, depending on the cultivar. Inside the seed coat 1 - 2 mm thick is a thin lining covering a single embryo, 4 - 7 cm long, 3 - 4cm wide, and 1 cm thick. Mango seed consists of a tenacious coat enclosing the kernel. The seed content of different varieties of mangoes ranges from 9% to 23% of the fruit weight [9] and the kernel content of the seed ranges from 45.7% to 72.8% [10].

Figure1: Mango seeds

The major components of mango seed are starch, fat and protein. The oil of mango seed kernel consist of about 44–48% saturated fatty acids (majority stearic) and 52–56% unsaturated. Mango seed kernels have a low content of protein but they contain the most of the essential amino acids, with highest values of leucine, valine and lysine. Mango seed kernels were shown to be a good source of polyphenols, phytosterols as campesterol, sitosterol and tocopherols. In addition, mango seed kernel could be used as a potential source for functional food ingredients, antimicrobial compounds and cosmetic due to its high quality of fat and protein as well as high levels of natural antioxidants. The mango stone obtained after decortication of mango seed can be utilized as adsorbent[11]. The Mango kernels have also been pharmacologically documented to have antioxidant, anti-tyrosinase, anti-inflammatory and hepatoprotective activities [12,13] as well as antienzymatic activities against snake venom [14,15].

Table1: Different components obtained during mango pulp extraction[16].

Components	*Percentage (%)*
Mango Pulp	45-65
peels	15-20
Pulpier waste	10-15
Stones	10-20

Therefore, the utilization of mango by-products especially mango seed may be an economical way to reduce the problem of waste disposal from mango production[11]. Mango biowastes, obtained after processing, contain large amounts of compounds with antioxidant activitythat can be reused to reduce their environmental impact[17].

Review of literature

A. Nutritional Significance

The results of proximate analysis of mango showed that mango seed is a good source of carbohydrate and protein. The amino acid profile of mango seed depicts that mango seed is very rich in glutamate while methionine has the lowest value. Among the essential amino acids, leucine has the highest value which is followed by arginine. The mango seed is also a good source of vitamins and minerals. The major saturated fatty acids in mango seed kernels oil were stearic and palmitic acids and the main unsaturated fatty acids are oleic and linoleic acids. The detailed results are shown in the tables given below.

Table 2: Proximate Compositions of Mango Seed[18]

Composition	Dry Weight(%)
Crude Protein	10.06 ± 0.12
Crude Oil	14.80 ± 0.13
Ash	2.62 ± 0.025
Crude Fibre	2.40 ± 0.01
Carbohydrate	70.12 ±1.34
Energy Content	453.92 ± 4.32 KJ/100 g

Each value is a mean of three determinations ± SEM

Table 3: Mineral elemental composition of mango seed kernel (mg/100g)

Minerals	Nzikou et al.,2010[19]	Fowomola, 2010[18]
Calcium, Ca	10.21	111.3
Magnesium, Mg	22.34	94.8
Potassium, K	158.0	22.3
Sodium, Na	2.70	21.0
Phosphorus, P	20.0	nr
Iron, Fe	nr	11.9
Zinc, Zn	nr	1.10
Manganese, Mn	nr	0.04

Note: nr, not reported

Table4: Amino acid profile (g/100 g of protein) of mango seeds[18].

Aminoacids	Lysine	Alanine	Histidine	Cysteine	Arginine	Valine	Aspartate	Methionine	Threonine
Quantity	3.13	6.40	2.31	2.30	5.17	3.80	6.33	1.04	2.04

Aminoacids	Isoleucine	Serine	Leucine	Glutamate	Tyrosine	Proline	Glycine	Phenylalanine
Quantity	3.23	2.93	8.40	13.00	3.17	3.00	3.50	4.46

Table 5: Vitamin contents (mg\100g) of mango seeds[18].

Vitamins	Amount(mg/100g)
A	15.27 (IU)
E	1.30
K	0.59
B1	0.08
B2	0.03
B6	0.19
B12	0.12
C	0.56

Table 6: Fatty acid composition of mango seed kernel lipid classes[20].

Fatty acid	Lipid fractions (% of total fatty acids) (mean±SD)
Myristic C14:0	0.5 ± 0.1
Palmitic C16:0	5.8 ± 0.3
Stearic C18:0	38.3 ± 1.2
Oleic C18:1	46.1 ± 2.3
Linoleic C18:2	8.2 ± 0.6
Linolenic C18:3	1.2 ± 0.2
Saturated fatty acids	44.6 ± 1.3
Unsaturated fatty acids	55.0 ± 0.5

Table 7. Antinutrients content (mg/100 g) of mango seed[18].

Alkaloid	Tannins	Phytate	Cyanide	Saponin	Oxalate	Trypsin inhibition(TIU/mg)
0.01 ± 0.0	1.03 ± 0.01	1.44 ± 0.01	0	0.04 ± 0	1.49 ± 0.01	18.42 ± 2.54

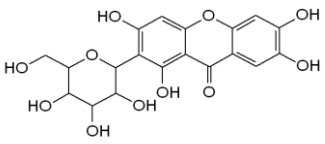
Each value is a mean of three determinations. ±SEM. Column values with different superscript letters are significantly different (P < 0.05).

B. Mango seed as a source of Bioactive Phytochemicals

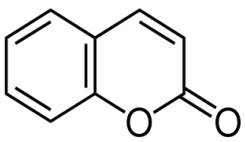
It contains several potent phytochemicals; some of them are listed below.

Table 8: Phenolic compounds in mango seed kernel extract (Mean ± SD)[20].

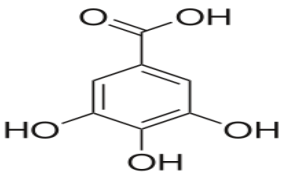
Phenolic compounds	Values (% of total compounds)
Tannin	20.7 ± 1.3
Gallic acid	6.0 ± 0.5
Coumarin	12.6 ± 0.9
Caffeic acid	7.7 ± 0.8
Vanillin	20.2 ± 2.1
Mangiferin	4.2 ± 0.4
Ferulic acid	10.4 ± 1.1
Cinammic acid	11.2 ± 1.0
Unknown compounds	7.1 ± 0.9



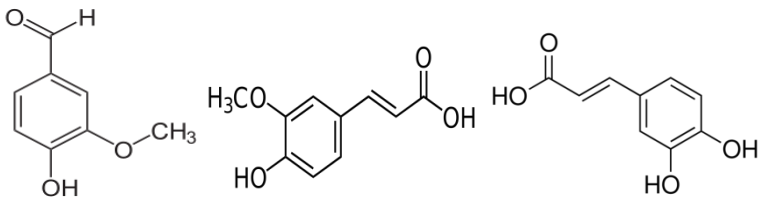
Mangiferin



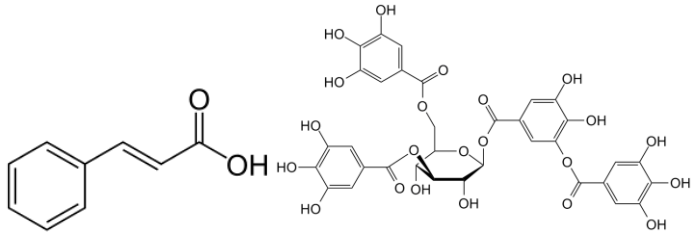
Coumarin



Gallic acid



Vanillin Ferulic acid Caffeic acid



Cinnamic acid Tannic acid (a type of tannin)

Figure2: Chemical Structure of Potent Phyto chemicals in Mango seed[21].

C. Antioxidant property of Mango seed

The antioxidant properties of Mango (Mangifera indica cultivar Chok-Anan) seed kernel (MSK) extracted by various extraction (shaking, refluxing, acid hydrolysis) methods were examined by applying 1, 1-diphenyl-2-picrylhydrazyl (DPPH) and 2, 2-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) (ABTS+) radical-scavenging assays and antioxidant activity using the ferric thiocyanate test (FTC). All three methods proved that extraction methods affected the antioxidant potential of MSK extracts. The antioxidant capacity of the acid hydrolysis extract had the highest value and was significantly ($P < 0.05$) higher than that of α-tocopherol, which is the commercially used natural antioxidant. Their phenolic composition (saponin, flavonoids, anthraquinones and tannins) and total phenolic content were also determined. The total phenolic content of MSK from different extraction methods varied between 90.03 and 285.70 mg of tannic acid equivalents per gram dry weight of product. Both flavonoids and tannins were major contributors to the phenolics in MSK. This research suggests that the extract has potential as a natural antioxidant[22].

D. Antimicrobial Activity

A study was conducted to investigate the in vitro antimicrobial activities of methanol and ethanol extracts of mango seed ("*Mangifera indica L*") against 25 representatives gram positive, gram negative, acid fast bacteria and fungi. Mango fruit seed were extracted by Soxhlet using methanol and ethanol as solvents. In vitro antibacterial activities of methanol and ethanol extracts of mango bulb showed inhibitions to tested organisms with variable inhibition zones. Except one organism (*Rhodococcus equi*), no resistance among the tested strains was shown. *Candida albicans* and *Aspergilllus niger* were both inhibited by the extracts. The methanol and ethanol extracts of mango seed showed good inhibitory effects against almost all tested strains. The inhibition zones produced by mango extract were less than those produced by standard positive control drug. This could be due to low diffusion rate of mango ex- tract in agarose medium, a thing needed to be further investigated. The products are potential new antimicrobial therapy in the ethnopharmacology domain[23].

In a study, the alcoholic extract from Thai mango (MangiferaindicaL. cv. 'Fahlun') seed kernel extract (MSKE) and its phenolic principles (gallic acid,methyl gallate and pentagalloylglucopyranose) demonstrated potent in vitro antibacterialactivity against Staphylococcus aureusand 19 clinical MRSA(methicillin−resistant Staphylococcus aureus) isolates in studies of discdiffusion, broth microdilution and time−kill assays[24].

Methanol extract used at different concentrations showed varying degrees of inhibition against Aeromonascaviae (ranging from 16 ± 2.41 mm to 24 ± 0.58 mm) except that the aqueous extract was found to be slightly active against the organism at lower concentrations with zones of inhibition ranging from 8 ± 1.22 mm to 11 ± 1.23 mm with measurable zones of inhibition at higher concentrations. Methanol extract of mango kernel at different concentrations inhibited the growth of A. caviae[25].

E. Antidiabetic Potential of Mango seed

A study was conducted to examine the hypoglycemic potency of seed kernels of *Mangifera indica* ethanol extract (MIEtE) in streptozotocin diabetic rats. Remarkable abnormalities were observed in serum and tissue parameters in hyperglycemic rats after streptozotocin administration. Administration of MIEtE, 300 mg/kg b. w./day for 14 and 21 days resulted in their normalization. The findings of the present study demonstrated M. indica to possess a potent hypoglycemic activity[26].

In an experiment *Mangifera indica* leaves and kernel seeds were extracted with absolute alcoholand used for the study. The oral hypoglycaemic effect, glucose tolerance test and antidiabetic activity of the *Mangifera indica* kernel seeds extracts were studied at 100 and 200 mg/kg b.wt. The antidiabetic potential of *Mangifera indica* leaves and kernel seeds extract were compared with tolbutamide 500 mg/kg b.wt.The result indicated that the alcoholic extract of

Mangifera indica leaves and kernel seeds at 200 mg/kg showed significant ($p< 0.01$) hypoglycaemic effect in the fasted normal rats after 3 h of drug administration, when compared with normal group. The *Mangifera indica* leaves and kernel seeds extracts were significantly increased insulin level at the dose level of 100, 200 mg/kg in alloxan induced diabetic Wistar rats[27].

F. Mango seed as Hypolipidemic agent

A study was aimed to evaluate the efficacy of Irvingiaga *bonensis* (African mango) seeds in the management of obesity. This was carried out as a double blind randomized study involving 40 subjects (mean age 42.4 years). Twenty-eight subjects received *Irvingiaga bonensis* (IG) (1.05 g three time a day for one month) while 12 were "on placebo" (P) and the same schedule. During the one-month study period all subjects were on "anormo caloric diet" evaluated every week by a dietetic record book. At the end, the mean bodyweight of the IG group was decreased by $5.26 \pm 2.37\%$ ($p < 0.0001$) and that of the placebo group by $1.32 \pm 0.41\%$ ($p < 0.02$). The difference observed between the IG and the placebo groups "was significant" ($p < 0.01$). The obese patients under *Irvingiaga bonensis* treatment also had a significant decrease of total cholesterol, LDL-cholesterol, triglycerides, and an increase of HDL-cholesterol. On the other hand, the placebo group did not manifest any changes in blood lipid components. *Irvingiaga bonensis* seed may find application in weight loss[28].

G. Mango seed as Antiobesity agent

A study investigated the anti-obesity effects of mango seed kernel extract with hot water (MSKE-W) in 3T3-L1 adipocytes and in a high fat diet (HFD)-induced obesity rat model. MSKE-W caused a significant decrease in the activity of glycerol-2-phosphate dehydrogenase in 3T3-L1 adi- pocytes without eliciting cell cytotoxicity and inhibited cellular lipid accumulation through down-regulation of transcription factors. In the animal model, rats fed an HFD containing 1% MSKE-W gained less weight than rats fed an HFD alone. The visceral fat mass in rats fed an HFD containing 1% MSKE-W tended to be lower than that in rats fed an HFD alone. The study concluded that MSKE-W provides a novel preventive potential against obesity[29].

H. Anti cancerous activity of mango seed

In a study the effect of mango kernel extract in the induction of apoptosis of the breast cancer (MDA-MB-231) cell line was examined. The results showed that the extract produced a time- and dose-dependent increase in pro-apoptotic proteins and oxidative stress markers with a corresponding decrease in anti-apoptotic markers. Thus, mango kernel extract has potential to be developed into an anti breast cancer mixture, and hence these results are worth studying further[30].

I. Anti diarrhoeal potential of Mango seed

A study was performed to examine the anti diarrhoeal activity of alcoholic and aqueous seed kernel extract of Mangifera indica (M. indica) on castor oil-induced diarrhoeal activity in Swiss albino mice. Mango seed kernels were processed and extracted using alcohol and water. Anti diarrhoeal activity of the extracts were assessed using intestinal motility and faecal score methods. Aqueous and alcoholic extracts of M. indica significantly reduced intestinal motility and faecal score in Swiss albino mice which supported the traditional claim on the use of M. indica seed kernel for treating diarrhoea in Southern parts of India[31].

J. Role of Mango seed in treatment of Haemorrhoid

In a survey carried out in tribal zones of Bihar revealed that powdered seed of Mangiferaindica Linn.is given, with or without honey has been used for the treatment of haemorrhoid.1-2gm kernel of mango stone orally taken twice a day can cure pile[32].

K. Mango seed as Hepatoprotective agent

Three polyphenolic principles, 1,2,3,4,6-penta-O-galloyl-beta-D-glucopyranose(PGG) ,methyl gallate ,and gallic acid, were isolated from the ethanolic extract of seed kernels of Thai mango (MSKE) (Mangiferaindica L. cv. "Fahlun") and quantified using a TLC scanning densitometric method. The MSKE and its isolates were investigated by studying their antioxidant capacities using four different methods, by determining their in vitro anti-inflammatory activities, and by evaluating their hepatoprotective potential against liver injury in rats induced by carbon tetrachloride (CCl4). The hepatoprotective effect of MSKE is clearly supported by its polyphenolic nature of the main principle, PGG, which exhibited potent antioxidant and anti-inflammatory activities[33].

L. Use of Mango seed as Animal Feed

Comparative study of growth traits and haematological parameters of Anak and Nigerian heavy ecotype chickens fed with graded levels of mango seed kernel (Mangifera indica) meal was conducted.One hundred fifty Anak and 120 Nigerian heavy local ecotype (NHLE) chickens were used to study the effects of feeding graded levels of mango seed kernel meal (MKM) replacing maize diet on growth traits and haematological parameters. The effect of breed and dietary treatments on growth performance and blood characteristics were determined. The results showed a significant ($P < 0.05$) breed effect on body weight and gain, shank length, thigh length, body width and body length. The growth traits of Anak breed were found to be superior to NHLE chickens[34].

CONCLUSION

Scarcity of food and resources is one of the critical problems which the world is facing now a day. India is enriched with natural heritage which needs to be sustainably used. There are many food commodities which lead to large scale production of bio wastes during their processing and its disposal is a major concern. Mango is one such fruit and its seed is reported to contain several potent phytochemicals which are responsible for amazing health benefits. It holds tremendous potential in food, medicine, pharmaceutical and cosmetic industries. Due to its antimicrobial properties it can be used as an alternative to synthetic antibiotics.Degenerative diseases like diabetes mellitus, cardiovascular diseases are widespread among people; due to the presence of bioactive polyphenolic compounds, minerals, antioxidants, vitamins in mango seed it can be used asanticarcinogenic, lipid lowering, weight reducing, anti-diabetic and rejuvenating agent.

REFERENCES

1. Bhatnagar HC and SubramanyamH: Some aspects of preservation, processing and export of mango and its products. Indian Food Packer, 1973;27(4): 33-52.

2. Wu S, Tokuda M, Kashiwagi A, Henmi A, Okada Y, Tachibana S,Nomura M: Evaluation of the Fatty Acid Composition of the Seeds of Mangifera indica L. and Their Application.J Oleo Sci. 2015;64(5):479-84.

3. Ramteke, R. S. and Eipeson, W. E. : Effect of additives on the stability of mango aroma concerntrate during storage. Journal of Food Science and Technology , 1997;34(3): 195-199.

4. Jahurul MH, Zaidul IS, Ghafoor K, Al-Juhaimi FY, Nyam KL, Norulaini NA, Sahena F, Mohd Omar AK.:Mango (Mangifera indica L.) by-products and their valuable components: A review. Food Chem. 2015 Sep 15;183:173-180.

5. SompongSruamsiri and PiroteSilma: Nutritive value and nutrient digestibility of ensiled mango by products.Maejo Int. J. Sci. Technol. 2009; 3(03), 371-378.

6. Berardini N, Fezer R, Conrad J, Beifuss U, Carle R, Schieber A. : Screening of mango (MangiferaindicaL.) cultivars for their contents of flavonolO- and xanthoneC-glycosides, anthocyanins, and pectin. J Agric Food Chem.2005; 53:1563–70.

7. Soong YY, Barlow PJ. : Quantification of gallic acid and ellagic acid fromlongan (DimocarpuslonganLour.) seed and mango (MangiferaindicaL.) kernel and their effects on antioxidant activity. Food Chem.2006; 97:524–30.

8. Eva Dorta, M. Gloria Lobo, and Monica Gonzalez. Reutilization of Mango By products: Study of the Effect of Extraction Solvent and Temperature on Their Antioxidant Properties. Journal of Food Science .2012;Vol. 71, 1.

9. Palaniswamy, K. P., Muthukrishna, C. R. and Shanmugavelu, K. G. : Physicochemical characteristics of some varieties of mango. Indian Food Packer .1974; 28(5): 12-18.

10. Hemavathy, J., Prabhakar, J. V. and Sen, D. P. : Drying and storage behavior of mango (Mangiferaindica) seeds and composition of kernel fat. Asean Food Journal.1988; 4(2): 59-65.

11. Kittiphoom, S. :Utilization of Mango seed.International Food Research Journal,2012; 19(4): 1325-1335.

12. Nithitanakool, S., Pithayanukul, P. and Bavovada, R.: Antioxidant and hepatoprotective activities of Thai mango seed kernel extract. Plant Medica,2009; 75, 1118- 1123.

13. Nithitanakool, S., Pithayanukul, P. and Bavovada, R. : Molecular docking studies and anti-tyrosinase activity of Thai mango seed kernel extract. Molecules, 2009; 14, 257-265.

14. Leanpolchareanchai, J., Pithayanukul, P., Bovovada, R. and Saparpakorn, P. : Molecular docking studies and anti-enzymatic activities of Thai mango seed kernel extract against snake venoms. Molecules, 2009; 14, 1404-1422.

15. Pithayanukul, P., Leanpolchareanchai, J. and Saparpakorn, P.: Molecular docking studies and anti-snake ve- nom metalloproteinase activity of Thai mango seed kernel extract. Molecules, 2009; 14, 3198-3213.

16. Central Food Technological Research Institute(CFTRI). 1985. Mango pulp concentration, p. 25-39. Mysore, India.

17. Dorta E, Lobo MG, Gonzalez M.: Reutilization of mango by products: study of the effect of extraction solvent and temperature on their antioxidant properties.J Food Sci. 2012 ; 77(1):C80-8.

18. Fowomola, M. A.: Some nutrients and antinutrients contents of mango (Magniferaindica) seed. African Journal of Food Science.2010; 4(8): 472 – 476.

19. Nzikou, J. M., Kimbonguila, A., Matos, L., Loumouamou, B., Pambou-Tobi, N. P. G., Ndangui, C. B., Abena, A. A., Silou, Th., Scher, J. and Desobry, S. : Extraction and characteristics of seed kernel oil from mango (Mangiferaindica). Research Journal of Environmental and Earth Sciences.2010; 2(1): 31-35.

20. Abdalla DM, Ahmed EM, Eman HEA and RehamME1H : Egyptian mango by-product 1. Compositional quality of mango seed kernel.Food Chemistry,2007;103(4): 1134-1140.

21. http://en.wikipedia.org/wiki/

22. Pitchaon Maisuthisakul: Antioxidant Potential and Phenolic Constituents of Mango Seed Kernel from Various Extraction Methods.Kasetsart J. (Nat. Sci.).2009; 43: 290 – 297.

23. Amgad A. Awad El-Gied, Martin R. P. Joseph, Ismail M. Mahmoud, Abdelkareem M. Abdelkareem, Ahmad M. Al Hakami, Mohamed E. Hamid.Antimicrobial Activities of Seed Extracts of Mango (MangiferaindicaL.) Advances in Microbiology, 2012, 2, 571-576.

24. PimsumonJiamboonsri ,PimolpanPithayanukul , RapepolBavovada ,Mullika T. Chomnawang The Inhibitory Potential of Thai Mango Seed Kernel Extract against Methicillin-Resistant Staphylococcus Aureus.Molecules 2011;16, 6255-6270.

25. TalbaA.M.,Suleiman M.M.,Raji M.A.,Oniye S.J.: Phytochemical Screening and In-vitro Antibacterial Activity of Mangiferaindica(Mango) Kernel on Aeromonascaviae. IOSR Journal of Pharmacy.2014; Volume 4, Issue 10, PP. 45-50

26. Gupta Rajnish, Gupta R.S.:Antidiabetic Efficacy of MangiferaIndica Seed Kernels in Rats: A Comparative Study with Glibenclamide. DiabetologiaCroatica , 2011, 40-4,107-112.

27. Ramesh Petchi R, Parasuraman S, VijayaC, GirishDaewhekar, Devika G S :Antidiabetic Effect of Kernel Seeds Extract of MangiferaIndica(Anacardiaceae),International Journal of Pharma and Bio Sciences,vol-2, issue1, 2011,385-393.

28. Judith L Ngondi, Julius E Oben and Samuel R Minka :The effect of Irvingiagabonensisseeds on body weight and blood lipids of obese subjects in Cameroon. Lipids in Health and Disease 2005, 4:12.

29. Mai Kobayashi, Isao Matsui-Yuasa, Maiko Fukuda-Shimizu, YoshinobuMandai, Masaki Tabuchi, Hiroshi Munakata, Akiko Kojima-Yuasa:Effect of mango seed kernel extract on the adipogenesis in 3T3-L1 adipocytes and in rats fed a high fat diet.Health.2013; Vol.5, No.8A3, 9-15.

30. Abdullah AS, Mohammed AS, Rasedee A, Mirghani ME, Al-Qubaisi MS: Induction of apoptosis and oxidative stress in estrogen receptor-negative breast cancer, MDA-MB231 cells, by ethanolic mango seed extract.BMC Complement Altern Med. 2015;15:45.

31. Rajan S, Suganya H, Thirunalasundari T, Jeeva S :Antidiarrhoeal efficacy of Mangiferaindica seed kernel on Swiss albino mice.Asian Pac J Trop Med. 2012;5(8):630-3.

32. PriyadarshniMeenakshi, KumariRitika, Shukla L.N.: Natural Pharmacology for Hemorrhoid/ Piles Treatment. International Journal of Pharmaceutical Research and Development, 2014; Vol 6(03):160 - 188.

33. Nithitanakool S, Pithayanukul P, Bavovada R. : Antioxidant and hepatoprotective activities of thai mango seed kernel extract.Planta Med. 2009; 75(10):1118-23

34. Mbunwen NF, Ngongeh LA, Okolie PN, Okoli EL : Comparative study of growth traits and haematological parameters of Anak and Nigerian heavy ecotype chickens fed with graded levels of mango seed kernel (Mangifera indica) meal.Trop Anim Health Prod. 2015