REVIEW

An exposition of medicinal preponderance of *Moringa oleifera* (Lank.)

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Abstract: Medicinal plants are believed to be a precious natural reservoir as they are assumed to have paranormal effects for the mankind. *Moringa oleifera* grows throughout most of the tropics and has numerous industrial and medicinal uses. This review acquaints with the consequence of fera (Moringaceae), a fast growing medicinal plant wide spread in tropical regions with height ranging from 5-10m. It has an enormous nutritional worth due to existence of vitamins and proteins. It is subsisted with many constituents. Its oil consists of oleic, tocopherols, stearic, palmitic, behenic and arachidic acid. Flavanoids and phenolics such as gallic acid, chlorogenic acid, ferulic acid, kaempferol, ellagic acid, quercetin and vanillin are present by means of leaf extract, being richest in phenolics and subsequent fruit and seed extract respectively, that are accountable for antioxidant activity of plant. Seeds have been pragmatic with active components as novel O-ethyl-4- (α -L-rhamnosyloxy) benzyl carbamate together with seven known compounds, 4 (α -L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin, niazirin, β-sitosterol, glycerol-1- (9 -octadecanoate), 3 -O- 6 -O-oleoyl- β -D-glucopyranosyl-b-sitosterol, and β - sitosterol- 3-X-O -β -D-glucopyranoside, that have been discerned to inhibit EBV-EA (Epstein– Barr virus-early antigen), that is persuaded by the cancer promoter. *M. oleifera* leaves, gums, roots, flowers as well as kernels have been unanimously utilized for managing tissue tenderness, cardiovascular and liver maladies, normalize blood glucose and cholesterol. It has also profound antimicrobial, hypoglycemic and anti-tubercular activities.

Keywords: *Moringa oleifera* (Lank.), cardiovascular, antioxidant, hypoglycemic, anti-tubercular activity.

INTRODUCTION

Since prehistoric times, our traditional medicine system as well as myths profess, that remedial flora as a entire or their components are being utilized in the entire forms of maladies effectively including antibacterial, anti-helmintic and anti-inflammatory etc. It is well known that, that medicinal preparations have been heralded in the market in recent times, from which most of them either not efficacious or has to build up conflict ensuing in reoccurrence once more. Plant originated drug, dole out as a sample to enlarge added efficacious and less noxious medicines. *Moringa oleifera* is inherent to North-West India with a common name drumstick tree pertinent to family Moringaceae. The height of tree falls in range of 5-10 m (Morton, 1991). Two species of *Moringa,* i.e., *M. concanensis* and *M. oleifera* are present in Pakistan, M.concanensisis found hardly ever, except *M. oleifera* is cultured extensively all over the moderate areas of the countryside (Qaiser, 1973). In Pakistan, widely cultivated areas of *M. oleifera* are Punjab plains, Sindh, Northwestern Frontier Province and the Baluchistan (Qaiser, 1973). It flourishes finest in a stifling blinkered atmosphere, as well as is ample next to the grimy beds of canals and torrents (Council of Scientific and Industrial Research, 1962). *M. oleifera* is a fast growing, has a drought-tolerant capacity, can tolerate poor soil, pH from 5.0-9.0 and a wide rainfall range that is 25 to 300+ cm per year (Palada and Changl, 2003). Its entirely grown-up, dehydrated kernels are circular otherwise three-edge form, and the kernel is found to be enclosed by a frivolously forested covering with three flimsy divisions (Council of Scientific and Industrial Research, 1962; Sengupta and Gupta, 1970; Qaiser, 1973). *M. oleifera* kernels enclose amid 33 and 41% w/w of vegetable oil (Sengupta and Gupta, 1970). To gather the flavors of confined populace, diverse categories of M. oleifera have been developed (Rajan, 1986). An assortment of parts of this plant, i.e., leaves, fruits, flowers and roots have conventionally been used for dietetic functions as vegetables (Qaiser, 1973; Siddhuraju and Becker, 2003). Fresh leaves have been exploited by Indian natives for the manufacturing of cow and buffalo ghee commencing butterfat. As an expensive foundation of vitamins A and C, its leaves uphold absorption, and are used in catarrhal afflictions and for curing lesions (Pal *et al.,* 1995). The leaves of *M. oleifera* blended with chicken stock are utilized by Philippine women to increase breast milk manufacturing (Chopra *et al.,* 1956). The raw seeds are valuable, as their aqueous extract is endowed with a flocculating protein to facilitate efforts as clarifying agent facade grimy and opaque water to tap-water in numerous African and Asian states and Central America

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(Gassenschmidt *et al.,* 1995). It has nutritional and medicinal values endowed with some useful minerals, vitamins and amino acids (Ramachandran *et al.,* 1980). Two types of leaves of *M. oleifera* are shown in fig. 1 and fig. 2 (Sreelatha and Padma, 2009).

Fig. 1: Mature leaves

Fig. 2: Tender leaves
Two types of leaves of *Moringa oleifera*

Physical and chemical parameters

Physical and chemical considerations of the concentrated oil were appraised and discovered as follows: iodine value: 68.00-71.80; saponification value: 180.60-190.50; refractive index (40°C): 1.4590-1.4625; density (24°C); 0.9036-0.9080 mg/ml; unsaponifiable matter: 0.70-1.10%.

Nutritional value and phytochemistry

The hexane-extracted oil content of *Moringa oleifera* seeds valued from 38.00 to 42.00%. It constituted protein, fiber and ash substances as 26.50-32.00, 5.80-9.29 and 5.60-7.50%, correspondingly. Tocopherols (α, γ, and δ) were embodied in oil up to 123.50-161.30, 84.07-104.00, and 41.00-56.00 mg/kg in that order. It was ascertained that oil comprises elevated echelons of oleic acid that is up to 78.59%, and palmitic, stearic, behenic, and arachidic acid following up to ranges of 7.00, 7.50, 5.99 and 4.21% correspondingly (Farooq *et al.,* 2003).

Specific phenolic composition

The Leaf, fruit and Seed concentrates (LE, FE and SE) were screened for their precise phenolic make up, that divulged the existence of phenolics comprehending gallic acid, chlorogenic acid, ellagic acid, ferulic acid, kaempferol, quercetin and vanillin .The quantities of these phenolics were found to be: gallic acid bracketing from 372.3 to 1034.4 lg /g, chlorogenic acid 81.3 to 488. 5 lg /g, ellagic acid 43.7 to 189. 1 lg /g, ferulic acid 51.5 to 128. 2 lg /g, kaempferol 68.2 to 197. 6 lg /g, quercetin 21.9 to 807 lg /g and vanillin 137. 1 lg /g.

Richest source of phenolics was leaf extract followed by fruit extract and seed extract in their richness. SE has also been found to be deficient of chlorogenic acid, ferulic acid, quercetin and vanillin. Vanillin is noted to be absent inside FE. Phenolic and flavonoid compounds have a direct contribution to antioxidant prospective (Prakash *et al.,* 2007b). Total phenolics content (TPC) and total flavonoids content (TFC) of concentrates were evaluated. TPC have been 105 .04, 72.76 and 45.81 mg gallic acid equivalents (GAE)/g dry concentrates in LE, FE as well as SE and 31.28, 8.75 and 9.93 mg quercetin equivalents (QE)/g for TFC, correspondingly. Petite TPC and TFC has been found in SE and maximum in LE as judge against FE. In fresh tissues of LE, FE and SE, ascorbic acid (A Acid) content has been 91.22, 106.95 and 62.11 mg/100 g. It has been reported that TPC of *M. oleifera* leaves ranges commencing 8.82 to 12.79 g GAE/ 100 g concentrate, 6.93 to 12.53g epicatechin equivalents (EE)/ 100 as well as 0.036 to 0. 043 g/100 g for TFC with amino acid substance, correspondingly in five diverse areas of Pakistan.

Chemical constituents

Phytochemical analysis of the ethanolic concentrate of *Moringa oleifera* pods divulged the existence of numerous bioactive components. Alkaloid, phenolics, flavonoids, flavonols, proanthocyanidins, terpenoids, tannin, and cardiac glycosides are the most obtrusive in it. Kernels of *Moringa oleifera* Lam. were inspected and bioactive compounds were secluded from the ethanolic concentrate. Compounds segregated were novel O-ethyl-4- (α -L-rhamnosyloxy) (fig. 3) benzyl carbamate, jointly with seven acknowledged constituents, 4 (α -L-rhamnosyloxy)-benzyl isothiocyanate (Eilert *et al.,* 1981) (fig. 4), niazimicin (Faizi *et al.,* 1994) (fig. 5), niazirin (Faizi *et al.,* 1994; Faizi *et al.,* 1995) (fig. 6), β -sitosterol, glycerol-1- (9-octadecanoate) (Buchnea *et al.,* 1971) (fig. 7), 3-O-6-O-oleoyl- β -D- glucopyranosyl-b-sitosterol (Ghosal *et al.,* 1984) (fig. 8) and β -sitosterol-3- X -O-β -D-glucopyranoside (Konoshima *et al.,* 1985) fig. 8. (Guevera *et al.*, 1999)

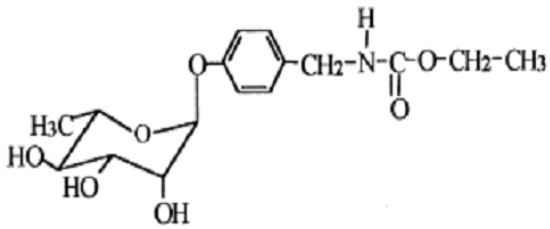


Fig. 3: O-ethyl-4- (α -l-rhamnosylox) benzyl carbamate)

Chemical constituent from chloroform extract

A new compound has been isolated from the chloroform extract of plant and structure was confirmed by analysis of its IR, H and C-NMR spectral data. (Nikkon *et al*., 2003) (fig. 9).

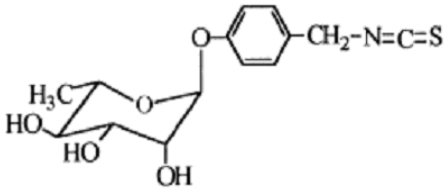


Fig. 4: 4(α-L-rhamnosyloxy) benzyl isothiocyanate

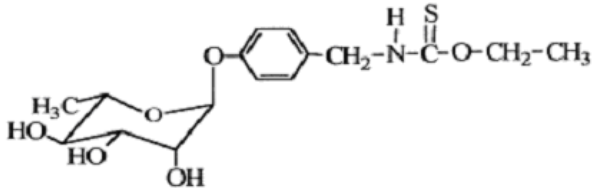


Fig. 5: Niazimicin

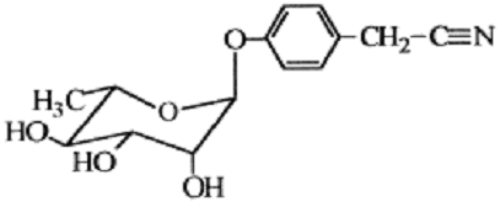


Fig. 6: Niazirin

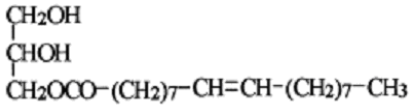
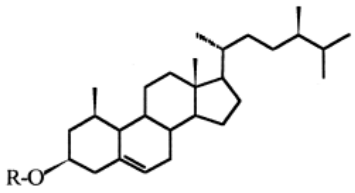


Fig. 7: Glycerol-1- (9-octadecanoate)

Extract has been analyzed by HPLC DAD-electrospray mass spectrometry and separation, quantification and identification of glucosinolates, phenolic, flavonoids and various other classes of phytochemicals has been done (Bennett *et al.,* 2006).



5: R = H
7: R = 6'-O-oleoyl-β-D-glucopyranosyl
8: R = β-D-glucopyranosyl

Fig. 8: 5:β-sitosterol 3-o-(6-o oleoyl- β -d-glucopyranosyl) -β-sitosterol β -sitosterol-3-o- β -d-glucopyranoside.

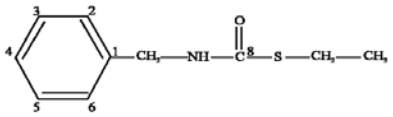


Fig. 9: Aglycon of Deoxy-Niazimicine (N-benzyl, S-ethyl,thioformate)

Glucosinolates	

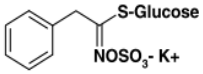
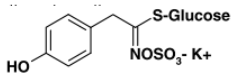

	

Fig. 10: Benzyl glucosinolate	**Fig. 11**: 4-hydroxybenzyl glucosinolate
Phenolics	

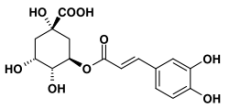
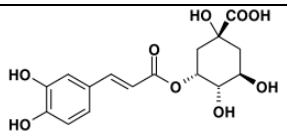
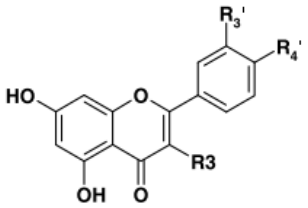

	

Fig. 12: 3Caffeoylquinic Acid 3CQA (Neochlorogenic Acid)	**Fig. 13**: 5-Caffeoylquinic Acid 5-CQA (Chlorogenic Acid)

Fig. 14: *Flavanoids* The structure of Kaempferol, Quercetin are shown in fig. 14 (Newton *et al.,* 2010)



K: Kaempferol, Q: Quercetin
K 3-O-Rutinoside ((R3= -GlcRha, R3'=H, R4'=OH (F7)
K 3-O Glucoside (R3= -Glc, R3'=H, R4'=OH (F9)
K 3-O (6"Malonylglucoside) (R3=-GlcMal, R3'=H, R4'=OH) (F13)
Q 3-O-Rutinoside (R3= -GlcRha, R3'&4'=OH) (F4)
Q 3-O Glucoside (R3= -Glc, R3'&R4=OH (F6)
Q 3-O (6"Malonylglucoside) (R3=-GlcMal, R3'&R4'=OH(F8)

Medicinal significance

Antimicrobial activity is exhibited by the majority of the fractions of the plant (Bhavasar *et al.,* 1965; Caceres *et al.,* 1991). Its parts have also been found to have notable pharmacological activity and are utilized for conventional treatment of diabetes mellitus (Bhishagratna, 1991; Sharma, 1981; Babu and Chaudhuri, 2005). Traditional treatment of liver maladies (Ruckmani *et al.,* 1998), rheumatism, venomous bites and cardiac stimulation (Chaudhary and Chopra, 1996) is also carried by it. Roots, Leaves, fruits and seeds of *Moringa* are utilized for the treatment of abdominal cancers, madness, scurvy, paralytic attacks, helminitic, bladder, prostate problems, sores and outer membrane maladies (Fuglie, 1999).

Leaves of this plant have been accounted to have assorted biological actions counting hypolipidaemic, anti-atherosclerotic, anti-oxidant (Chumark *et al.,* 2008; Iqbal and Bhanger, 2006), immune boosting, hypotensive (Faizi *et al.,* 1994) and tumor suppressive effects (Murakami *et al.,* 1998). *M.oleifera* leaves, flowers, gums, roots and seeds are comprehensively utilized for management of tissue swelling, heart and liver infections, normalize blood sugar as well as cholesterol (Limaye *et al.,* 1995; Rao and Misra, 1998). *M. oleifera* are applied as plaster to diminish the inflammation and rheumatism. The root, flower, fruit and folio have pain reliever and anti-inflammatory activities (Tarapti *et al.,* 2009). Studies reported analgesic and anti-convulsive actions of methanolic concentrate of *Moringa oleifera*. The ME extract of roots accounted noteworthy CNS depressant accomplishment in a dose-dependent manner (Gupta *et al.,* 1999). It has been reported that 4(α -L-rhamnosyloxy) –benzyl isothio-cyanate , niazimicin 3-O-(6-O- oleoyl- β -D-glucopyranosyl)- β -sitosterol and β -sitosterol-3- O- β -D-glucopyranoside inhibit EBV-EA (Epstein–Barr virus-early antigen) that is persuaded by the tumor supporter, 12-O- tetradecanoyl-phorbol -13-acetate(TPA) and act as a potential antitumor promoters. It has been suggested that niazimicin 3 is a powerful antitumor supporter in chemical carcinogenesis (Guevera *et al.,* 1999). *M. oleifera* has been instituted to be effectual in cutaneous HSV-1 disease in mice. *M. oleifera* has been noted to reveal restorative antiviral effectiveness in vivo. *Moringa oleifera* deferred the progress and development of skin lesion and diminished the transience of contaminated mice. This plant concentrate demonstrated anti-HSV-1 action in vitro but did not exhibit anti-polio virus or anti-measles virus activity. Therefore, it is suggested that this plant extract showed therapeutic efficacy for HSV-1 infection in vivo possibly based on its anti-HSV-1 specific activity observed in vitro. *Moringa oleifera* has also been effective against thymidine kinase (TK)-lacking HSV-1 and phosphonoacetate-resistant HSV1 strains (Lipipun *et al.,* 2003). It was well-reputable that excess of doses of APAP (Acetaminophen) that is used as an analgesic and antipyretic, consequences in centrilobular necrosis, fatty infiltration, lymphocytic as well neutrophil permeation and significantly elevates the serum transaminases and ALP actions as well as tumbling the commotion of glutathione (Yen *et al.,* 2007). *M. oleifera* extract has displayed a hepatoprotective outcome subsequent a noteworthy decline in serum transaminases, alanine aminotransferase (ALT), aspartate aminotransferase (AST) and ALP actions and by averting the alterations seen in the management with APAP. *M. oleifera* restores the bustle of glutathione, which diminishes next to APAP management. It has been observed that plant concentrate is uniformly helpful to silymarin in avoiding the augmentation in hepatic enzymes, when confronted with hepatotoxic prescribed amount of APAP (fig. 15) (Fakurazi *et al.,* 2008).

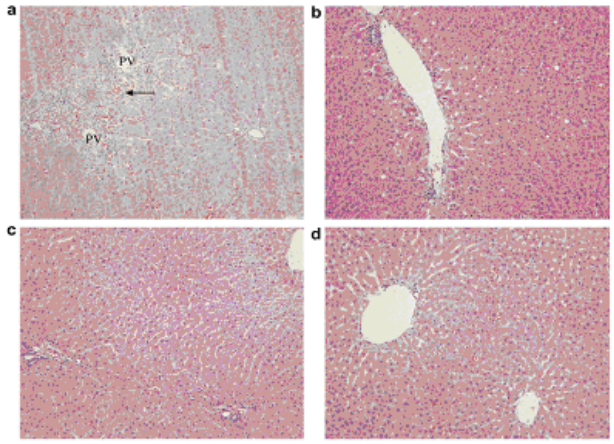


Fig. 15: *Moringa oleifera* Lam (MO) as a hepatoprotective agent against acetaminophen (APAP) in rats. (a) Pretreatment of distilled water + APA showing submissive inflammation with necrosis of cells around perivenular area (PV); (b) pretreatment of MO (200/mg/kg) + APAP (normal liver architechure) (c) pretreatment of MO (800 mg/kg) + APAP.(normal liver architechure) (d) Pretreatment of silymarin (200/mg/kg) + APAP (normal liver architecture).

Hypoglycemic activity of *Moringa oleifera*, with significant blood glucose lowering activities has been confirmed (Ajit *et al.,* 2003). It has been suggested that *M. oleifera* has hypolipidaemic action. *M. oleifera* has anti-atherosclerotic consequence jointly with a lessening in body mass. *Moringa oleifera* has been observed to augment faecal emission of cholesterol and phospholipid accompanied by means of diminution in hepatic cholesterol, triglyceride and phospholipid ranges due to incomplete reticence of cholesterol production de novo or by reticence of cholesterol assimilation, in this manner depleting serious intracellular collection of sterols in the liver (Late *et al.,* 2003). An assortment of fractions of Moringa roots, flowers, bark, and stem counting seeds, acquire antimicrobial activities (Lockett *et al.,* 2000; Anwar and Rashid, 2007) Seed extracts of *Moringa oleifera* have been studied for its antimicrobial activities (Kebreab *et al.,* 2005; Jamil *et al.,* 2007). The rudimentary, supernatant, filtrate and dialyzed samples inhibits the expansion of all microbes to diverse degrees. The regions of growth reticence have shown superior compassion adjacent to the bacterial strains (*Staphlocuccus aureus, Pasturella multocida, Bacillus subtilis and Escherichia coli*) as compared to the fungal strains (Fusarium solani and Rhizopus solani). Minimum inhibitory concentrations (MIC) extracts showed that *Pasturella multocida* and *Bacillus subtilis* were manifold insightful strains. *Moringa oleifera* was additionally valuable beneath squat temperature, or restrained temperature circumstances (fig. 16) (Jabeen *et al.,* 2008).

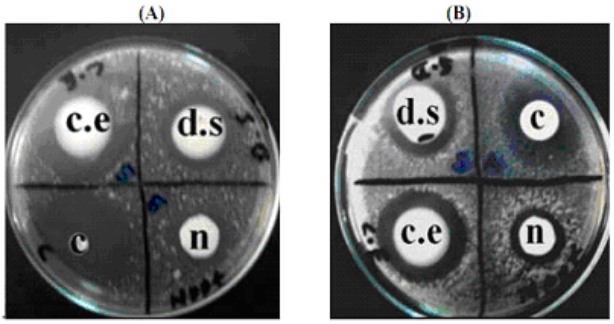


Fig. 16: *Moringa oleifera* demonstrating antibacterial activity against *Bacillus subtilis* [A] and *Staphlococcus aureus [B]* through *Standard control(c), Crude extract (c.d), Dialyzed sample (d.s) and Supernatant (n) (ammonium sulphate precipitation)*

Moringa Oleifera has been suggested to be used as anti-tuberculosis agent due to its active constituents .4-(a-l-Rhamnosyloxy), benzyl isothiocynate, segregated from aqueous essence of seeds (Gautam *et al.,* 2007). It has been reported that foods affluent in antioxidants, bestow protection against degenerative diseases including cancer, coronary heart diseases and Alzheimer's disease (Pezzuto and Park, 2002; Razali laboratory). Phenolics are important constituents of *Moringa oleifera* and some of their pharmacological effects could be imputed to the presence of these valuable constituents. Phenolic contents are probably responsible for the antioxidant activity of *Moringa oleifera* that are constituents of many plants and are of great scientific interest due to their antioxidant effects.

M. oleifera has been found as a non-conventional source of oil, with significantly high oxidative stability, affirming the presence of natural antioxidants (Anwar and Bhanger, 2003) Significant variations have been promulgated in oil content of *Moringa* seeds as function of agroclimatic locations. Anwar *et al.,* and Shahid *et al.,* (2005) had reported that agroclimatic locations and seasons have significant effects on the antioxidant activity of *M. oleifera* leaves. Activity in from cold areas was relatively higher than temperate regions. Similarly, in December (cold month) antioxidant activity was higher and lowest in June (hot month). The antioxidant activity of *M. oleifera* extracts has been reported; ranged from 34.73 to 85.77%. The activity of extracts was in order: LE > FE > SE. The LE proved to endow a much content of antioxidant compounds than FE and SE. The LE (85.77%) had also effective AOA than standard a-tocopherol (75.19%) (fig. 17 and fig. 18) (Iqbal *et al.*, 2006).

Moringa oleifera has also been known for its potent anthelmintic activity (Tarapti *et al.,* 2009). Ethanolic concentrates of *Moringa oleifera* demonstrates the maximum action against typhoid, whereas aqueous concentrates showing the negligible action. The activities plant extract was analogous to those of antibiotics; ciprofloxacin, cotrimoxazole and chloramphenicol, that are conventionally used for treating typhoid fever (Doughari *et al*., 2007). *Moringa oleifera* has been reported anti-fungal outcome on *T. rubrum, T. mentagrophytes, E. Xoccosum and M. canis.* Folio crude concentrates and sub-fractions have been examined and found to have little effect on dermatophytes (Chuang *et al.,* 2006). The medicinal importances of various parts of Moringa oleifera are illustrated in table 1.

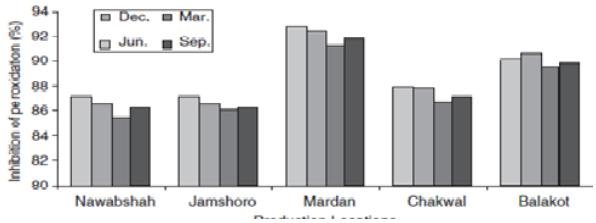


Fig. 17: *Moringa oleifera* showing antioxidant activity in linoleic acid system

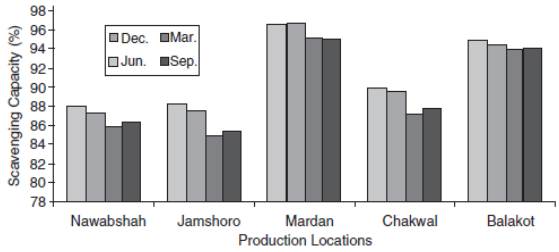


Fig. 18: Methanolic extract's scavenging capacity on superoxide anion radicals

Table 1: illustrating medicinal importance of various parts of *Moringa oleifera*

Plant Part	Medicinal importance	References
Seed	Analgesic, anti-inflammatory activity. Antioxidant, Antimicrobial	(Tarapti *et al.*, 2009; Iqbal *et al.*, 2006; Kebreab *et al.*, 2005; Jamil *et al.*, 2007).
Fruit	Analgesic, anti-inflammatory activity, Antioxidant	(Tarapti *et al.*, 2009; Iqbal *et al.*, 2006)
Leaves	Hypolipidaemic, antiatherosclerotic Analgesic, anti-inflammatory activity. Antioxidant	(Chumark *et al.*, 2008; Iqbal and Bhanger, 2006; Tarapti *et al.*, 2009; Iqbal *et al.*, 2006)
Root	Analgesic, anti-inflammatory activity. CNS depepressant	(Tarapti *et al.*, 2009; Gupta *et al.*, 1999)

CONCLUSION

Moringa oleifera has been found to exposit hypolipidaemic, anti-inflammatory, antioxidant, antimicrobial, antifungal, anti-tuberculosis and analgesic effects. It can therefore be exploited as a most priority candidate, for its potential to treat disastrous diseases of the modern times. Further planning to study the mechanism of action and constituents of the *Moringa* plant may provide stunning capabilities to revolutionize pharmacological products. The chemical constituents of *Moringa oleifera* are very well investigated and documented, the further studies and emphasis should spotlight on probable mode of action of the isolates and possible structural– activity relationship.

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