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# PHYTOMEDICINAL VALUE OF *Moringa oleifera* WITH SPECIAL REFERENCE TO ANTIPARASITICS

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Plants are claimed as folk medicine for their therapeutic activity. *Moringa (M.) oleifera*, known as the "miracle tree", is greatly esteemed for its unique nutritional and medicinal value. Nutritively, it contains essential, disease-preventing nutrients. The methanolic and ethanolic extracts of plants have anthelmintic activity through paralysis of helminths. The compounds found responsible so far for their anthelmintic activities include: niazirinin, glycoside, niazirin and three glycosides from mustard oil, niaziminin A, B and 4- [4'-O-acetyl- α -L-rhamnosyloxy) benzyl] isothiocyanate isolated from leaves; D-glucose, D-mannose, ascorbic acid, protein and polysaccharide isolated from mature flowers; 0-[2'-hydroxy-3'-(2''-heptenyloxy)] propylundecanoate, methyl-p-hydroxybenzoate, thiocarbanates, isothiocyanate, nitriles, 0-ethyl-4-[(α-1-rhamnosyloxy)-benzyl] carbamate, and β-sitosterol isolated from whole pods of *M. oleifera*. Parasites are one of the major causes of diseases in human and animals. Due to parasitic infections livestock industry suffers from huge economic losses. The parasites which have been treated using different parts of *M. oleifera* include: Dracunculiasis (guinea worm), schistosomes and trypanosomes. Plant extracts may serve as potential candidates in future to exterminate helminthiasis in human and livestock populations. Hence, isolation, characterization and *in vivo* and *in vitro* efficacy trials of *M. oleifera* derivatives on scientific grounds are direly needed to elucidate it as a noteworthy candidate as neutraceutical and anthelmintic.

**Keywords:** Phytomedicine, *Moringa oleifera*, antiparasitic, neutraceutical, ethnoveterinary medicine

## INTRODUCTION

Plants are being used all over the world for the cure of countless disease conditions. Treatment of diseases using plants or their extracts is called as "phytotherapy". It is sometimes also called as herbalism, plant medicine and herblore. Phytotherapy is considered under the category of Pharmacognosy, which studies medicines acquired from substances occurring in nature.

Since ancient times, traditions and folklore declare plants and their parts to be used against ailments. In northern Iraq, about 60,000 years old at the burial site of Shanidar IV, huge amount of pollens have been recovered belonging to 8 species of plants, of which 7 are used as phytomedicine nowadays (Solecki and Ralph, 1975). Records testify the use and study of herbs even old as 5000 years. At that time; the Sumerians used laurel, caraway and thyme for medicinal purpose (Sumner, 2000). Egyptians, considered expert in the use of herbal remedies, used castor oil, coriander, mint, indigo, garlic and opium etc. in 1000 BC (Sumner, 2000). Usage and art of cultivation is mentioned in the first part of Bible about mandrake, caraway, wheat, barley and rye. Herbs e.g. turmeric were used in Ayurveda medicine since 1900 BC in India (Aggarwal *et al.,* 2007). Sushruta in 6$^{th}$ century BC explained 700 herbal preparations, 64 mineral preparations and 57 preparations of animal origin. Ma-Huang shrub is considered as the reason for the introduction of ephedrine to the list of modern medicines (Sumner, 2000). Greeks and Romans were expert in the usage of herbal therapy against various ailments. Scripts from Hippocrates paved the way for Western medicine, so as the scripts of Galen (Loudon, 2002). Hippocrates used to prescribe empirical herbal mixtures along with the prescription of rest and balanced diet; whereas, Galen used plants, animals and mineral ingredient sources for drugs formulation and prescribed larger dosage regimen (Loudon, 2002). Arab traders also had access to the markets of China and India, from where they purchased raw plant materials. In 13$^{th}$ century, Ibn-al-Baitar depicted 1400 plants, foods and drugs, and he also discovered 300 of his own (Boulanger, 2002). In the same century, Abu-al-Abbas, Al-Nabati and Andalusian-Arab botanist and educator of Ibn-al-Baitar, initiated experimentation in the field of Materia Medica (Huff, 1996). He verified transcripts that were supported by pillars of observation and testing. This advancement of the "Materia Medica" leads to the development of pharmacology.

Among all other diseases, parasites are major havoc for livestock in all the tropical countries (Githiori *et al.,* 2004). Parasites either external or internal, when attack their host, lead to stunted growth, drop down productivity, increase in death rate and serious economic disturbance (Iqbal *et al.*, 1993; Sykes, 1994; Kochapakdee *et al.,* 1995). This review

comprehensively describes few selected herbs having antiparasitic activity and potential of *Moringa oleifera* as an emerging candidate for phytochemical control of parasites.

***Plants having anti-parasitic activity*:** The plant kingdom is the oldest best known opulent pool of herbal antibacterials, anthelmintics and insecticides (Satyavati *et al.,* 1976; Zaman *et al*., 2012; Babar *et al*., 2012; Hamad *et al*., 2013). Uncountable figures of medicinal/herbal plants have been used against parasites. Up till now, no complete record of plants being used as antiparasitics is there. Usually the knowledge about antiparasitics passes from one generation to the next (Cox, 2000). Round the globe, the major plants having antiparasitic activity are: *Allium sativum* (Iqbal *et al.,* 2001), *Annona senegalensis* (Ibrahim *et al.,* 1984), *Acacia albida* (Nwude and lbrahim, 1980), *Adhatoda vesica* (Lateef *et al.,* 2003), *Agati gratifola* (Kalesaraj, 1975), *Ageratum conyzoides* (Sharma *et al.,* 1979), *Aglaia odorattissima* (Nanda *et al.,* 1987), *Agrimonia (Ag.) eupatori, Ag. pilosa* (Xiao and Lin, 1986), *Alangium lamarckii* (Dubey and Gupta, 1969), *Albizia (Al.) anthelmintica* (Minja, 1989), *Al. coriavera* and *Al. lebbeck*, *Aloe barteri*, *Alpinia calcarata* and *Cucuruma aramatica* (Kalesaraj, 1975), *Amomum aromaticum, Ammora wallichii, Calamintha umberosa, Picus religiosa, Sentia myrtina* and *Sumplocos crataegoides* (Kaushik *et al.*,1981), *Anacardium occidentale* (Garg and Kasera, 1982a,b), *Ananas (An.) comosus, An. sativus* (Neogi *et al.,* 1964), *An. sativus* (Chakraborty *et al.,* 1976), *Annona(Ann.) cherimolia, Ann. muricata, Ann. braziliensis* and *Molinema dessetae* (Bories *et al*., 1991), *Anogeissus (Ano.) leiocarpus* (Ibrahim *et al.,* 1984), *Ano. leiocarpus, Securinega virosa*, *Khaya (K.) senegalansis* and *Nauclea latifolia, Anthocephalus indicus* (Kaushik *et al.,* 1981), *Areca (Ar.) catechu, Artabotrys odoratissimus* (Siddiqui and Garg, 1990), *Artemisia (Art.) abrotanum* (Krause, 1993), *Art. absinthium* (Guarrera, 1999), *Art. annua* (Shuhua *et al.,* 2000), *Art. brevifolia* (Iqbal *et al.,* 2004), *Art. herbaalba, Art. inforescence* (Hammond *et al.,* 1997), *Art. maritime* (Sherif *et al.,* 1987), *Art. mesatlantica, Art. monosperma* (Abu-Niaaj *et al.*,1996), *Art. pallens* (Nakhare and Garg, 1991), *Art. scoparia* (Naqvi *et al.,* 1991), *Azadirachta (Az.) indica, Melia azedarach, An. comosus, Vernonia anthelmmtica, Embelia ribes, Fumarla parviflora* and *Caesalpinia crista, Bixa orellana, Boswellia (Bo.) dalzelii* (Nwude and Ibrahim, 1980), *Bo. serrata* (Girgune *et al.,* 1978), *Buddlea asiatica, Butea (Bu.) frondosa* (Shilaskar and Parashar, 1989), *Bu. frondosa* (Mehta and Parashar, 1966), *Bu. frondosa* (Lal *et al.*,1976), *Bu. monosperma* (Iqbal *et al*., 2006), *Bu. superba, Caesalpina crista* (Akhtar *et al.,* 1985), *Calliandra (Ca.) calothyrsus* (Parker and Palmer, l991), *Ca. portoricensis* and *Calotropis (Cal.) procera* (Iqbal *et al*., 2005), *Carica papaya* (Lal *et al.,* 1976), *Carum copticum* (Kalesaraj, 1975), *Cassia (Cs.) alata, Cs. accidentalis* (Ibrahim *et al.,* 1984), *Emblic myrobalans* (Gaind *et al.,* 1964), *Chenopodium album* (Akhtar *et al.,* 1999), *Chloroylon swientenia, Chrysanthemum spp.* (Rebrassier, 1934), *Chrysophyllum cainito, Cinnamomum tamala* (Girgune *et al.,* 1978), *Cissampelos mucromata* (Minja, 1989), *Citrus (Ci.) acida, Ci. aromatic* and *Ci. medico* (Kalesaraj, 1975), *Combretum mucronatum* (Sofowora, 1982), *Commiphora mukul* (Kakrani and Kalyani, 1984), *Croton macrostachys* (Minja, 1989), *Cucurbita (Cu.) rnexicana* (Shrivastava and Singh, 1967), *Cu. moschata* (Xiao and Lin, 1986), *Cu. pepo* and *Momordica charantia* (Sharma *et al.,* 1971), *Cyathocline lyrata* (Shrivastava, 1979), *Cymbopogon (Cy.) nardus* and *Cy. citratus* (Kokate and Varma, 1971), *Cyperus rotendus* (Girgune *et al.,* 1979), *Datura (Da.) quercifolia* and *Da. metal* (Kaushik *et al.*,1981), *Diospyros mollis* (Sen *et al.,* 1974), *Dodonea viscosa* (Sharma and Singh, 1989), *Embelia (Em.) kilimandschiraca* (Minja,1989), *Em. schimperi* (Bogh *et al.,* 1996), *Em. ribes* (Akhtar *et al*., 1990; Qureshi and Sabir, 1979), *Erythrina senegalensis* (Nwude and Ibrahim, 1980), *Eupatorium triplinerve* (Garg and Nakhare, 1993), *Evodia rutaecarpa* (Perrett and Whitfield, 1995), *Feruia foetidissima*, *Ficus religiosa* (Iqbal *et al.,* 2001), *Flemingia (Fl.) vestita* (Pal and Tandon, 1998), *Fl. vestita* (Kar *et al.,* 2002), *Fumaria parviflora* (Kailani *et al.,* 1995), *Gardenia lucida* (Girgune *et al.,* 1979), *Hedychium (He.) coronarium* and *He. spicatum* (Dixit and Varma, 1975), *Helleborus niger* (Kalesaraj, 1975), *Heracleum sosnoskyi, Hyoscyamus niger* (Akhtar and Ahmad, 1990), *Inula racemosa* (Mishra *et al.,* 1979), *Jugulans regia, Musa paradisaca* and *Scindapsus officinalis* (Sharma *et al.,* 1971), *K. senegalansis, Lagenaria siceraria* (Akhtar and Riffat, 1987), *Lantana camaravar, Lawsonia inermis* (Nwude and Ibrahim, 1980), *Leucaena leucocephala*, *Limnophila conferta* (Reddy *et al.,* 1991), *Litsea chinensis* (Mishra *et al.,* 1979), *Macuna prurita* (Neogi *et al.,* 1964), *Mangifera indica* (Kalesaraj, 1975), *Matteuccia orientalis* (Shiramizu *et al.,* 1993), *Mitragyna stipulosa* (Sofowora, 1982), *M. oleifera* (Akhtar and Ahmad, 1990), *Nicotiana (N.) tabacum* and *Nigella sativa* (Kailani *et al.,* 1995), *Peganum harmala* (Akhtar and Ahmed, 1991), *Piper (Pi.) betle* (Ali and Mehta, 1970), *Psitacia integrrima* (Mishra *et al.,* 1979), *Psoralea coylifolia* (Akhtar, 1985), *Punica granatum* (Prakash *et al.,* 1980), *Quisqualis indica* (Xiao and Lin, 1986), *Randia dumetorum* (Mishra *et al.,* 1979), *Rapanea melanoploeos* and *Sapindus trifoliatum* (Lal *et al.,* 1976), *Saussurea lappa* (Akhtar and Hassan, 1985), *Senecio lyratiparitus* (Minja, 1989), *Solanum nodiflorum* (Nwude and Ibrahim, 1980), *Spigelia anthelmia* (Assis *et al.,* 2003), *Swertia chirata* (Shilaskar and Parashar, 1989), *Tiinospora rumphii, Tribulus terrestris* (Chakraborty *et al.,* 1979), *Uvaria (U.) hookeri, U. narum* (Padmaja *et al.,* 1993), *Vernonia (V.) amygdaline* (Alawa *et al.,* 2003), *V. anthelmintica* (Mehta and Parashar, 1966), *Withania (W.) coagulans* (Singh *et al.,* 1982), *Zanthoxylum alatum* (Kalyani *et al.,* 1989) and *Zingiber officinale* (Adewunmi *et al.*,1990).

Predominant reports of medicinal plants in Pakistan include those of Akhtar *et al*., 1984, 1985, 1987, 1990, 1991 and 1999; Abbas *et al*., 2010; Hussain *et al*., 2010; Iqbal *et al*., 1993, 2001, 2004, 2005 and 2006; Sindhu *et al*., 2010; Awais *et al*., 2011; Badar *et al*., 2011; Hussain *et al*., 2011; Ashfaq and Ashfaq, 2012. According to their findings the most important medicinal plants present in Pakistan are *Acacia nilotica, Allium (Al.) cepa, Al. sativum, Aloe vera, Areca catechu, Az. indica, Brassica campestris, Cal. procera, Capsicum annuum, Citrullus colocynthis, Ci. medica, Coriandrum sativum, Curcuma longa, Eruca sativa, Ferula asafetida, Foeniculum vulgare, Linum usitatissimum, Mallotus philippinensis, Me. azedarach, Mentha arvensis, M. oleifera, N. tabacum, Phoenix dactylifera, Pi. nigrum, Terminalia chebula, Trachyspermum ammi, Triticum aestivum, V. anthelmintica, W. coagulans* and *Ziziphus jujube.*

***Introduction to Moringa*:** Moringa belongs to family Moringacae which contains thirteen species (Olson, 2002) from tropics to subtropics of the world in the form of tiny herbs to massive trees (Ramachandran *et al.,* 1980). It is being cultivated in Ethiopia, Kenya, Afghanistan, Namibia, Bangladesh, Angola, Pakistan, Madagascar, Africa and India (Stephenson and Fahey, 2004; Trapti *et al*., 2009). Moringa is also widely distributed on tropics of the world including Ghana, Uganda, Egypt, Sierra Leone, Philippines, Nicaragua, Kenya, Haiti and many more. It can thrive well with minimal moisture contents as its roots store moisture contents for long period. It also thrives well in Pakistan, Bangladesh, Sri Lanka, Tropical Africa, Arabia, Cambodia and Central North and South America (Qaiser *et al.,* 1973; Sofowora *et al.,* 1982; Somali *et al.,* 1984; Morton *et al.,* 1991; Mughal *et al.,* 1999; Shahzad *et al*., 2013).

Most extensively cultivated species under this family is *M. oleifera.* Vernacular names of Moringa in different languages of the world include: Rawag (Arabic), Daintha, Dandalonbin (Burmese), La Ken (Chinese), Maissang, Moring, Moxing (Konkani), Moringa, Moringueiro (Portuguese), Murunga (Sinhalese), Angela, Ben, Moringa (Spanish), Mrongo, Mzunze (Swahili), Sahjan (Hindi), Horseradish tree, Drumstick tree, Moringa (English), *Moringa oleifera* (Latin), Surajana (Sanskrit), Amukira (Tamil), Keramaddinagaddi and Nugge (Kannada), Mulakkaya (Telgu), Muringa, Murinna and Sigru (Malayalam), Achajhada and Shevga (Marathi), Saragvo (Gujarati), Sajiwan or Swejan (Nepali), Sojne danta (Bengali), Sajana or Sujuna (Oriya), Suhanjana (Punjabi), Sojina (Assamese) and Murunga, Sojina (Sinhalese). Specifically, *M. oleifera* is also known as: the Ben oil tree, Benzolive tree, Kelor, Marango, Mlonge, Moonga, Mulangay, Nebeday, Saijhan, Sajna, Miracle tree and "Mothers best friend" (Coppin, 2008). It is being cultivated in Himalayas in north western India and all over the tropics.

A diverse range of species belonging to genus Moringa have been reported from Africa (*M. arborea, M. borziana, M. longituba, M. oleifera, M. peregrine, M. pygmaea, M. rivae, M. ruspoliana, M. stenopetala, M. drouhardii, M. hildebrandtii, M. ovalifolia*) and from India (*M. concane nsis, M. oleifera*) is cultivated.

***History of the miracle plant*:** *M. oleifera* is highly valued member of genus Moringa, which comprises of thirteen species (Mabberley, 1997). Plantation of Moringa started from the West Indies in the 19$^{th}$ century. Later on, people from Asia and West Africa started using it as food supplement. Mostly, the leaves and pods were used as food while seed oil was used for lubrication. Moringa is the tree of tropical and sub-tropical countries with medium size, no or very rare branching, flowers are creamy white and sweetly scented (Sastri, 1962). Silvi-culture of *M. oleifera* is being introduced to elicit poverty and malnutrition therefore improving health status (Parrotta *et al.*, 2001).

***Medicinal activity of Moringa*:** The identified species of Moringa have been reported for their specified geographical uses like; traditional use to combat anemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis, cough, diarrhea, eye and ear infections, fever, glandular swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis (India), intestinal worms (Malaysia and Puerto Rico), skin infections and sores (Guatemala), for anemia and glandular swelling (Philippines).

As *M. oleifera* is a medicinal plant, so all of its parts are utilized against various diseases worldwide. Roots being used against rheumatism, as anti-inflammatory, cardiac/ circulatory tonic, carminative, joint pains, kidney pain, as laxative, as abortion inducer, rubefacient, stimulant in paralytic afflictions and vesicant (Sastri, 1962; Dahot, 1988; Ruckmani *et al.,* 1998). Leaves are being utilized against catarrh, scurvy, purgation, applied as poultice, rubbed for headaches, fevers, otitis, sore throat, bronchitis, eye infections; leaf extract regulates the level of glucose in the body and lowers down the swelling in glands (Sastri, 1962; Dahot, 1988; Morton, 1991). Stem and bark are used as rubefacient, vesicant, to cure eye diseases, prevent the spleenomegaly and tubercule formation in the neck, eradicates tumors and resolves the ulceration. Root bark extract is dropped in ear to relieve aches and also relieves tooth aches (Bhatnagar *et al.,* 1961). Gum acts as rubefacient and astringent. Moreover, gum when emulsified with sesame oil, acts as preventive therapy against asthma, dysentery, fever, headache, intestinal complaints and acts as abortion inducer. Flowers are of great value in the field of medicine so used as abortion inducer, anti inflammatory, relieves the muscular diseases, antitumerous, against spleenomegaly, lowers down the level of fats and lipids in the serum,

decrease lipids levels of liver and heart (Bhattacharya *et al.,* 1982; Dahot, 1998; Mehta *et al.,* 2003). Seed extract decreases liver lipid peroxides (Faizi *et al*., 1998; Lalas and Tsaknis, 2002).

The research also supports the traditional medicinal uses of *M. oleifera* as antipyretic (Sutar *et al.,* 2009) and antiasthmatic (Mahajan *et al.,* 2007 and 2009; Agarwal *et al.,* 2008) due to its ethanolic extracts present in leaf and seed. Its wound healing ability is attributable to seeds containing ethanol and ethyl acetate (Hukkeri *et al*., 2006; Rathi *et al.,* 2006). In addition, it is antithyroid (Tahiliani and Kar, 2000), anti-inflammatory, antiarthritic, analgesic (Rao, 1998; Mahajan *et al.,* 2007; Sutar *et al.,* 2008; Sashidhara *et al.,* 2009), hypocholesterolemic (Zlatkis *et al.,* 1953; Ghasi *et al.,* 2000; Mehta *et al.,* 2003; Chumark *et al.,* 2008), antimicrobial (Kurup and Rao, 1954; Das *et al.,* 1957; Bhatnagar *et al.,* 1961; Eilert *et al.,* 1981; Caceres *et al.,* 1991; Dahot *et al.,* 1998; Nikkon *et al.,* 2003; Chuang *et al.,* 2007; Ayanbimpe *et al.,* 2009; Lürling and Beekman, 2010), anaphylactic, hepatoprotective (Ruckmani *et al.,* 1998; Pari and Kumar, 2002; Hamza, 2007; Fakurazi *et al.,* 2008; Selvakumar and Natarajan, 2008; Hamza, 2010), radioprotective (Rao *et al.,* 2001), antiulcer (Akhtar and Ahmad, 1995; Pal *et al.,* 1995; Ruckmani *et al.,* 1998; Debnath and Guha, 2007; Devaraj *et al.,* 2007), antispasmodic (Caceres *et al.,* 1992; Gilani *et al.,* 2007), antihyperglycemic (Ndong *et al.,* 2007; Jaiswal *et al.,* 2009).

Major compounds in *M. oleifera* to fight against diseases are: 4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(α-L-rhamnopyranosyloxy) benzyl isothiocyanate**,** niazimicin**,** pterygospermin**,** benzyl isothiocyanate and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate (Kerharo, 1969; Sashidhara *et al.,* 2009)**.** Table 1 provides the list of important chemical constuients present in *M. oleifera* which have extensively been reported by Fahey (2005). Isoleucine builds proteins and enzymes, leucine works with isoleucine to enhance energy level**.** Lysine helps in accurate absorption of calcium and aids in the antibody production**.** Methionine predominantly supports the sulfur provision to the body therefore decreases the irritation in the bladder. Phenylalanine yields the chemical transmitters between nerve cells and brain. Threonine is an integral portion of fibrous proteins. Tryptophyan supports immune system and reduces cholesterol level while valine helps in muscle coordination. Body manufactures non-essential amino acids, when nutrient supply is proper. These non-essential amino acids are also found abundantly in Moringa having diverse types of functions e.g. alanine helps in energy build up, arginine is helpful in the release of the growth hormones and improves immune status, aspartic acid helps rid from cellular waste, cystine functions as an antioxidant, glutamic acid is food for the brain, glycine promotes the oxygen supply which is integral part in the cell-making phonemonon, histidine is used in the treatment of rheumatoid arthritis, allergies, ulcers, and anemia while serine helps in he glucose preservation in the liver as well as in muscles whereas proline is tremendously significant for the appropriate functioning of tendons and joints. It also helps to sustain the integrity and strength of heart muscles. Tryrosine helps in nerve impulse transmission process so in this way it helps coverup depression, improves memory, increases mental alertness, promote healthy functioning of the thyroid, adrenal and pituitary glands.

***Nutritive value of Moringa*:** The key components of Moringa are omega-3 and omega-6 fatty acids, deic, saponins, palmitic acid, glycoside,stearic acid, gum, vitamins (A, B1, B2, B3 and C), protein, minerals (calcium, iron, phosphorus, magnesium) (Kasolo, 2010). The leaves, flowers and pods are used as substantial sources of ascorbic acid, alpha-tocopherol beta-carotene, calcium, folic acid, iron, nicotinic acid, pyridoxine, vitamins, and riboflavin (Dahot, 1988). A compound, pterygospermin, has been stated to possess potent antibiotic and antifungal activity (Das *et al.,* 1957). The root bark contains alkaloids namely moringinine and moringine (Shukla *et al.,* 1988). Upon the nutritional analysis of moringa pods, fresh raw leaves and dried leaf powder have been explored (http://www.edlagman.com/moringa/moringa-fresh-leaf-vs-dried-leaf.pdf) containinig moisture (86.9%, 75% and 7.5%), calories (26.0, 92.0 and 205.0), proteins (2.5g, 6.7g, 27.1g), fat (0.1g, 1.7g and 2.3g), carbohydrates (3.7g, 13.4g and 38.2g), fiber contents (4.8g, 0.9g and 19.2g) respectively. High levels of calcium, phosphorous, magnesium, potassium, copper, iron, oxalic acid and sulphur and other trace minerals are also observed. Vitamins profile is feboulous like it contains carotene, thiamin, riboflavin, nicotinic acid, ascorbic acid and tocopherol acetate.

Earlier studies on the phytochemical analysis has shown the presence of alkaloids, amino acids, carbohydrates, flavonoids, glycosides, proteins, saponins, steroids and tannins in ethanolic extracts of plant (Rastogi *et al.,* 2009;). The leaves are rich source of vitamin A, B and C, protein and essential amino acids. Cattles which are kept on feeding of Moringa plant, have shown an increase of 32% in weight gain and 43% to 65% in milk production (Mathur, 2006). Moringa leaves contains a plenty full of vitamin A, calcium, iron, vitamin C, potassium and high levels of protein (Singh, 2007; Silja, 2008). The seeds have higher contents of oil i.e. about 35% while left over meal is having about 65% of protein content (Anwar *et al.,* 2005). The dry seed powder and defatted meal is a flocculent and can be used in water purification to settle down sediments and undesirable organisms (Muyibi *et al.,* 2009). Traditionally its roots are applied as plaster to reduce the swelling and rheumatism.

**Table 1. A review of chemical constituents of various body parts of *Moringa oleifera***

| Parts | Phytochemical constituents | References |
|---|---|---|
| Leaves | Glycoside niazirin, niazirinin and three mustard oil glycosides, 4- [4'-O-acetyl- α -L-rhamnosyloxy) benzyl] isothiocyanate, niaziminin A and B | Faizi *et al.*, 1994; Verma *et al.*, 2009; Anwar *et al.*, 2005; Makkar and Becker, 1996; Geervani and Devi, 1981; Das, 1965; Lakshminarayana *et al.*, 2005; Seshadri and Nambiar, 2003 |
| Stem | 4-hydroxymellein, vanillin, β-sitosterone, octacosanic acid and β-sitosterol | Saluja *et al.*, 1978; Faizi *et al.*, 1994 |
| Bark | 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate | Kerharo, 1969 |
| Whole gum exudates | L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, Dmannose, D-xylose and leucoanthocyanin | Bhattacharya *et al.*, 1982 |
| Roots | 4-(α-L-rhamnopyranosyloxy) benzylglucosinolate and Benzylglucosinolate | Sashidhara *et al.*, 2009 |
| Mature flowers | D-mannose, D-glucose, protein, ascorbic acid, polysaccharide | Faizi *et al.*, 1994; Ruckmani *et al.*, 1998 |
| Whole pods | Nitriles, isothiocyanate, thiocarbanates, 0-[2'-hydroxy-3'-(2''-heptenyloxy)] propylundecanoate, 0-ethyl-4-[( α -1-rhamnosyloxy)-benzyl] carbamate, methyl-p-hydroxybenzoate and β-sitosterol | Faizi *et al.*, 1998; Nagar *et al.*, 1981, 1982; Roy *et al.*, 2007 |
| Leaves and Pods | Glycosides-carbamate,thiocarbamate, and isothiocyanate Ascorbic acid, oestrogenic substances, β-sitosterol, iron, calcium, phosphorus, copper, Vitamin A, B, C, α-tocopherol, riboflavin, nicotinic acid, folic acid, pyridoxine, β-carotene, proteins, essential amino acids – methionine, cystine, tryptophan and lysine Novel bioactive nitrile glycosides-Niaziridin and niazirin | Faizi *et al.*, 1994; Makkar and Becker, 1996; Tsaknis *et al.*, 1999; Lako *et al.*, 2007; Verma *et al.*,1976; Shanker *et al.*, 2007; Jadhav *et al.*, 2000 |
| Leaves, flowers and fresh beans | α and gamma tocopherols | Guevara *et al.*, 1999 |
| Mature seeds | Crude protein, Crude fat, carbohydrate, methionine, cysteine, 4-(α- L-rhamnopyranosyloxy)-benzylglucosinolate, benzylglucosinolate, moringyne, mono-palmitic and di-oleic triglyceride, benzyl isothiocynate | Eilert and Wolters, 1981; Lalas and Tsaknis, 2002; Bennett *et al.*, 2003; Katre *et al.*, 2008; Fahey *et al.*, 2001 |
| Seed oil | Vitamin A, beta carotene, precursor of Vitamin A | Anwar *et al.*, 2005; Tsaknis *et al.*, 1999; Anwar and Bhanger, 2003; Ogunbinu *et al.*, 2009; Banerji *et al.*, 2009 |

***Antiparasitic activity of M. oleifera*:** It is observed that *M. oleifera* is having potent anthelmintic activity and its gum is being used as an anti-filarial agent (Kushwaha *et al.*, 2011). The most targeted parasite species with the use of *M. oleifera* are helminths including Dracunculiasis, schistosomes and trypanosomes (Fahey, 2005). *In vitro* activity of *M. oleifera* has shown some antiprotozoan activity (Kohler *et al.*, 2002) and is larvicidal because of soluble lactin present in its seed extract. It hinders the process of larval development and due to its heam-agglutinating activity therefore it causes mortality in *Aedes aegypti* (Coelho *et al.*, 2009; Ferreira *et al.*, 2009). Water extract of *M. oleifera* is known to have larvicidal, pupicidal as well as adult mosquito killer properties against the *Culex quinquefasciatus* (Ashfaq and Ashfaq, 2012). It is being used as antimalarial (Eilert *et al.*, 1980; Gbeassor *et al.*, 1990). Major anthelmintic activity is shown by the ethanolic extracts of the plant which when used at various concentrations can cause paralysis and death of the worms. Various concentrations of Moringa extract take varied period of time for paralysis and death of the worms as 25 mg/ml takes 14.32±2.2 min and 63.57±12.6 min, 50 mg/ml takes 8±1.6 min and 52.33±3.1 min while 100 mg/ml takes 6±1.2 min and 45±11.4 min respectively, as experimentally noted by Gosh *et al.*, (2005).

***Miscellaneous uses of Moringa oleifera*:** Some of the uses for Moringa encompass: alley cropping for biomass, leaves and treated seed-cake as animal forage (Mahatab *et al.*, 1987), leaves for biogas production, crushed leaves as domestic cleaning agent, wood for blue dye preparation, living trees for fencing the houses, seed-cake as natural fertilizer, juices extracted from the leaves as foliar nutrient,

leaves as green manure, gum from tree trunks, powdered seeds used to clarify honey and sugar cane juice, flower nectar as honey (Rajan, 1986), whole plant is used as medicine, ornamental plantings, dumped off leaves as bio-pesticide, wood to prepare pulp (Guha, *et al.,* 1968), bark for roping, bark and gum used in tanneries for tanning hides due to presence of tannin, dry seed powder for water purification purpose (Muyibi *et al.,* 2009).

***Conclusions*:** Chemotherpay remains the corner stone in the treatment of majority of infectious diseases in the under developed countries. However, the efficacy is reduced over time against pathogens (including parasites) due to development of resistance against these drugs. In addition, the drug toxicity in the host leads to depressed immune status making it more prone to other infectious diseases (Chang, 2011). Under the given circumstances, use of plants and/or plant-derived medicines for the cure of infectious diseases, in general, and parasitic diseases, in specific, is justified. Lot of work has already been carried out during the past decade by various scientists of our country regarding antiparasitic efficacy of plants and their scientific validation (Abbas *et al*., 2010; Hussain *et al*., 2010; Sindhu *et al*., 2010; Awais *et al*., 2011; Badar *et al*., 2011; Hussain *et al*., 2011). Keeping in view the expected benefits and detailed nutritive and medicinal profile of *M. oleifera*, it is suggested that effective candidates from this miraculous plant should be extracted for potent activity against prevalent parasitic agents in livestock and human population. As discussed above, *M. oleifera*, an edible tree, being cultivated worldwide in almost all tropical countries, and is progressively being utilized to meet nutritional deficiency. Leaves are rich in nutrients and have high protein content therefore widely used in medicine by physicians, healers, nutritionists and community leaders, for the treatment nutrition deficiency and other ailments related to it, but yet no clinical trials are applied for the testification of its efficacy to add it up as nutrition supplement. The development and implementation of dietry *M. oleifera* leaves has been described in "Diffusion of innovations theory" and it highlights the need for a scientific consensus on the nutritional benefits. It is suitable and economically friendly nutrient-rich food stuff for nutrient deficient populations. *M. oleifera* is capable to meet its high rate of overall utilization, macro and micronutrients avalibility, swift growth capability, high leaf yield and can survive in harsh climatic conditions. Therefore it is strongly recomended that *M. oleifera* should be adopted as a unique pan-tropical dietary plant not only for humans because of its good nutritional profile, but also for livestock rations as it contains high level of vitamins and minerals and its seeds are rich in protein. At present, cultivation of this plant is done in selected southern zone of Punjab; Researchers should try to explore the details of this plant on logical scientific grounds to provide guidelines for its use in rationing and human supplementation. There is a dire need to start the cultivation of Moringa on national scale. In this connection, the agriculture section of the Government should facilitate farmers for technical and financial assistance whatever possible to boost up its production making it easily available for humans as well as livestock.

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