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BRIEF PROFILE OF DOCTOR TREE (*MORINGA OLEIFERA* LAM.)

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ABSTRACT

The paper presents a brief profile of Doctor Tree (*Moringa oleifera* Lam.) - including phytochemical constituents, minerals, vitamins, aminoacids, fatty acids, nutritional and pharmaceutical properties of its various morphological components, seed-oil and exudates (gum). Its antioxidant, antidiabetic, anti-atherosclerotic, antimicrobial and nematicidal activities and its effectiveness in many diseases, frequently reported in literature, have been described. Its role in mitigating climate change and global warming and efficacy against *Anopheles gambiens* and *Aedes aegyptii* is also reported in literature. *M. oleifera* contains some 163 phytochemicals of which 40 are phenolics and flavonoids and it is active in more than 80 diseases including neuro-pharmacological effects against Alzheimer's disease, anticancer and antitumour activity, wound closure and tissue regeneration, anti-urolithiasis, testicular damage-repairing, antihypertensive, anti-ulcerogenic, radio-protector etc. It is a nice fodder and suggested for poverty alleviation in poor countries.

Key-words: *Moringa olifera* Lam., phytochemicals, nutritional, environmental and medicinal importance.

INTRODUCTION

Doctor tree *(Moringa oleifera* Lam.), belongs to Family Moringaceae. The genus name comes from "Murungai" (Tamil) means twisted pod and species name is from Latin words "Oleum" (oil) and "ferre" (to bear). It is a common cultivated rapid-growing tree. There are some 126 vernacular names of the plant (Shamim *et al.,* 2018) – Sohanjna (saijan), Swenjera (Sindhi), Doctor Tree, Arenge Behan, Clarifier tree, Drumstick tree, Horseradish tree, Benzoline tree, Ben oil tree, Super food tree, Miracle tree, Tree of life, Moringa, etc. Native to Indo-Pak sub-continent. Widely distributed in many countries for its nutritional and medicinal importance – India, Pakistan, Bangladesh, Afghanistan, South-East Asia, Philippines, Indonesia, Taiwan, Caribbean, Africa, and America. The history of *M. oleifera* dates back to 150 BC. Dhakar *et al.* (2011) have reported that ancient Mauryan warriors of India were fed with Moringa leaf extract for extra energy.

M. oleifera grows from Sea level to 1400m. It coppices well (Shamim *et al*., 2018). It can survive in very dry arid deserts with less than 400 mm annual rainfall (iwacu- Burundi, org/englishnews/Moringa-the–never-die-tree) and under various stressful conditions (Mahmood *et al.*, 2010). It has quite wide ecological amplitude. Sometimes referred to as "never die" tree (Swati *et al.*, 2018). It requires loamy and sandy soil (Thurber and Fahey, 2010). As regard to its growth, pollarding, coppicing and lopping or pruning are recommended for encouraging branching. (Denton and Grubben, 2004). Khan *et al.* (2021) have described its foliar micromorphology of its seedlings. It is a very useful plant, and every part of the plant is used by the mankind for millennia (Martin *et al.,* 2013), one way or the other (Abd Rani *et al.*, 2018) and in more than 80 countries (Mahmood *et al*., 2010). The wood may be used for fire and poor-quality charcoal and in making paper pulp. A blue dye is produced from wood in Senegal and Jamaica (Halder and Kosankar, 2017). The oil extracted from nuts (seeds) is called 'Ben' or Behen' oil used as lubricant, in cosmetics and applied in rheumatism. The seeds are considered antipyretic. They are oleaginous and contain 38.4 % protein and 34.7 % fatty oil. The seed cake is used as fertilizer (NISC, 1998). *M. oleifera* is a miracle plant (Padayachee and Baijnath, 2012). It is good food and one of the best food supplements. It contains all essential amino acids (unusual for a plant) (*http://muneilla.wordpress.com/2012/04/16/moringa-global-warming-and you/*). It is a fertilizer, efficient fuel, livestock feed and extremely safe edible plant (Mahmood *et al.,* 2010). There are many uses of *M. oleifera* in human and animal nutrition (Hanuk, 2018). Ganatra-Tejas *et al.* (2012) have reviewed from various publications that *M. oleifera* have very many traditional and pharmacological characteristics. It improves soil and provides raw materials for food, purification of water and cosmetics (Velázquez-Zavala *et al.,* 2016). Its wood yields blue dye (Misra *et al.,* 2011). A brief profile *of M. oleifera* benefits is presented in this paper.

MATERIALS AND METHODS

Hundreds of research papers have so far been published on nutritional, biological, traditional, phytochemical, pharmaceutical, pharmacological and other characteristics of *M. oleifera* (to cite a few: Das *et al.,* 1957; Delaveau and Baiteau, 1980; Villasenor *et al.,* 1989a and b; Faizi and coworkers, 1994; 1997; Muyibim and Evison, 1994; Gillani *et al.,* 1994; Gassenschmidt *et al.,* 1995; Pollard *et al.,* 1995; Makkar and Becker, 1996; 1997;1999; Njoku and Adikwu, 1997; Ramachandran *et al.,* 1980; Foidl *et al.,* 2001; Rao *et al*., 2001; Anonymous, 2003; Ganatra–Tejas *et al.,* 2012; Tahir *et al.,* 2017; Mehta *et al.,* 2003; Annongu *et al.,* 2014; Luqman *et al*., 2012; Alegbeleye, 2018; Agbogidi and Ilonda, 2012; Anwar and Rashid, 2007; Anwar *et al.,* 2007; Kalogo *et al.,* 2000; Kasolo *et al.,* 2010; Moyo *et al.,* 2011, 2012; Dhakar *et al.,* 2011; Nda Bigengeser and Narasiah,1998; Fahey, 2005; Manzoor *et al.,* 2007; Isitua *et al.,* 2015; Stevens *et al.,* 2013; Martin and coworkers, 2013; Charoensin, 2014; Velázquez-Zavala *et al.,* 2016).; Padayachee and Baijnath, 2012; Iqbal and Bhanger, 2006; Atawodi *et al.,* 2010; Sidhuraju and Becker, 2003; Bennet *et al.,* 2003; Torres-Castillo *et al.,* 2013; Razis *et al.,* 2014; Uniugbe *et al.,* 2014; Leone *et al.,* 2015; Guevara et al., 1996, 1999; Mehta *et al.,* 2011a; Mishra *et al.,* 2011; Rani and Arumugam, 2017; Hussain *et al.,* 2014; Swathi, 2016; Igado and Oladale, 2016; Harimalala *et al.,* 2017; Maqsood *et al,* 2017; Kumar, 2017; Singh, 2017; Shamim *et al.,* 2018; Abd Rani and associates, 2018; Singh *et al.,* 2019; Mahmood *et al.,* 2010; Gopalakrishnan *et al.,* 2016; Padmalochana, 2018; Shanmugavel *et al.,* 2018; Mahfuz and Piao, 2019; Pandey *et al.,* 2019; Aleksic, 2020; González – Romero *et al*., 2020; Subramonie *et al.,* 2020, Srivastava *et al.,* 2020; Bekoe, 2020; Almeida *et al.,* 2021; Bhalla *et al.,* 2021; Lui *et al.,* 2021; Fidrianny and coworkers, 2021; Prithiviraj and Sumathy, 2021; Rubio-Sanz *et al.,* 2021; Basillo-Heradia and Gutierrez-Grijalava, 2022 (a very informative book on biological and pharmacological aspects of genus *Moringa* such as antioxidant, anti-inflammatory, antidiabetic properties, phytochemical and bioactive characteristics, genetic diversity and agronomy) and many more).

This paper on profile of doctor tree was prepared on consultation of some 300+ publications on the subject characteristics.

BRIEF PROFILE OF *MORINGA OLEIFERA* LAM.

1) Phytochemicals

Many workers have studied phytoconstituents of *M. oleifera*. Garga *et al.* (2019) have reviewed and described the presence of flavonoids, tannins, saponins, cardiac glycosides, steroids, alkaloids, volatile oils, Anthraquinones, saponins glycosides, in leaves and seeds extract of this plant. Bhalla *et al*. (2021) identified 25 phytochemicals in aq. extract and 54 phytochemicals in methanolic extract of *M. oleifera* leaves. Regarding the presence of Anthraquinones the reports are controversial. Anthraquinones were reported to be completely absent from the leaf extracts by Kwaghe and Ambali (2009) in fresh and dry leaf samples. When extracted with chloroform, ethyl acetate or n-Butanol and Aqueous and Aqueous + Methanol extracts of leaves collected from Kibwezi, Makeuri County of Kenya (Okumu et al., 2016) and Gujrat, India (Dodiya and Amin, 2015) also exhibited no anthroquinones. Sankhalkar and Vernekar (2016), however, reported the presence of anthraquinone from leaf of *M. oleifera* collected from Chowgule College, Goa (India). They reported more or less similar spectrum of phytochemicals in leaves and flowers. In addition to these phytochemicals, Udofia *et al.* (2020) reported coumarins, lipid and terpenoids in *M. oleifera*. Singh *et al.* (2021) have comprehensively described phytoconstituents of *Moringa* in their review based on 89 references.

Table 1. Physico-chemical characteristic of *M. oleifera* seeds from Kohat, NWFP and Sindh, Pakistan (Anwar and Rashid, 2007) and different localities of Egypt viz. M. Asuit, M. Oraby and M. Monofya (Barkat and Ghazal, 2016).

Phytochemicals (%)	Localities				
	NWFP, Pakistan	SINDH, Pakistan	M. Asuit, Egypt	M. Oraby, Egypt	M. Monofya, Egypt
Seed oil content	34.80	40.39	29.61	30.06	28.62
Moisture	8.90	5.70	7.5	6.57#	6.54
Avail. Carbohydrate	-	-	20.03	19.0	20.29
Fibre	7.54	7.20	10.92	12.16	11.05
Ash	6.53	6.60	4.73	5.06	4.22
Protein	31.65	29.36	35.54	34.51	36.53
Calories value	-	-	450.36	451.1	451.3

The phytochemical composition of *M. oleifera* is reported to vary with the stages of the maturation of the plant after pruning. Early stage (10^{th} week after pruning has highest carbohydrate concentration (55.14%), at mid stage (15^{th} week) moisture is high (6.3%) and late stage (20^{th} week) protein is the highest (28.08%) (Bamishaiye *et al.* (2011) among the stages. The diverse bioactive chemicals are active in several ailments. Anwar and Rashid (2007)

have presented physico-chemical characteristics of seed and seed oil from Kohat, NWFP (Khyber Pakhtunkhwa) and Sindh and Barkat and Ghazal (2016) from some Egyptian localities (Table 1). Seed oil content is significantly high in Sindh plants but protein content in somewhat lesser amount. The oil content of seeds was 34.80% from Kohat and 40.69% from Sindh – quite higher than that in Egyptian accessions. Seeds were rich in protein as well (around 30%) but somewhat higher in Egyptain plants. High oleic acid content (around 73.22%) was reported in local Egyptian provenance (Barkat and Ghazal (2016) who suggested that *Moringa* seed oil may be used for edible and commercial applications. Udofia *et al.* (2020) presented phytochemical composition of leaves as outlined in Table 2. In Kenya sample protein concentration was significantly lower as compared to that of Kohat and Sindh of Pakistan. Protein content of leaves of *Moringa* rivals the protein contents of eggs. Leaves have more protein than seeds (Aleksic 2020). Ash, arachidic acid, brassicasterol, β-carotene, campestanol, carbohydrates, stearic acid, 4-(alpha-L-rhamnosterol)-benzylglucosinolate, 28-isovenasterol, alpha-tocopherol, 4-(alpha-L-rhamnosyloxy) benzyliso Thiocyanate, Behenic acid, Beta-sitosterol, fiber, oleic acid, palmitic acid, proteins, water, 2,4-methylene-cholesterol etc. are but few general phytochemicals of *Moringa* (Misra *et al.,* 2011; Abdulkarim *et al.,* 2005).

Table 2. Phytochemicals of M. *oleifera* leaves from Kenya (Udofia *et al.,* 2020).

Phytochemicals	Leaf - Mean % composition g/100g DW
Carbohydrates	41.97 ± 0.72
Flavonoids	1.12 ± 0.20
Alkaloids	0.06 ± 0.0
Phenols	46.81 ± 3.20
Saponins	14.00 ± 0.51
Ash	14.82 ± 0.65
Crude fibre	1.58 ± 0.45
Crude Lipid	6.06 ± 1.63
Crude Protein	23.05 ± 0.62
Moisture	12.92 ± 0.02

Fahal *et al.* (2018) have reported on phytochemicals of pods of *M. oleifera* – alkaloids 3.1, Flavonoids 5.2, saponins 6.5, sterols 4.7 and tannins 22.9 %, substantially different from Kenyan leaves (cf. Table 2). A number of elemental studies have been conducted by some workers on *M. oleifera* (Udofia *et al.,* 2020 from Kenya; Valdez-Solana *et al.,* 2015 from Mexico; Nweze *et al.,* 2014 from Nigeria, Zaini *et al.* (2019) from Algeria, Leone *et al.* (2015) from Chad and Haiti and Yaméogo *et al.* (2011) from Berkina Foso. There was presence of several heavy metals (Table 3) in differentially varying amounts with locality. Moyo *et al.* (2011) reported Selenium and Boron to be 363 and 49.3 mg /kg DW in Moringa leaves. The content of Arsenic in San Pedro (Mexico) sample was reported to be higher than the permissible limit. According to Ganantra-Tejas *et al.* (2012) Moringa is richer in Ca (4X of Milk), K (63 X of Milk and 3X of Banana), Mg (36 X of Egg), and Fe (25X of Spinach). They firther reported that it has protein (2X of Yoghurt / Milk; Polyphenol (8X of red wine) and Amino acids (2X of Black vinegar. Islam *et al.* (2021) reported Mg to be 635 ± 8.66 mg/100g and P (75 mg / 100g).

Table 3. Elemental analysis of *Moringa oleifera* from various countries. (*, Higher than the permissible limit.).

Elements (mg / 100 g)	Kenya (Udofia *et al.,* 2020)	Mexico (Valdez-Solana *et al*. (2015)		Nigeria (Nweze *et al*, 2014)-	Southern area of Algeria (Zaini *et al.,* 2019)	Chad & Haiti (Leone *et al*., 2015)	Berkina Faso (Yaméogo *et al.,* 2011)
		Lombarda	San Pedro				
Cu	0.08 ± 0.07	1.03 ± 0.47	0.41 ± 0.0	10.0	0.81 ± 0.01	ND	NP
Mn	0.84 ± 0.04	-	-	-	5.21 ± 0.03	ND	NP
Fe	0.21 ± 0.13	19.37 ± 6.6	7.07 ± 0.4	30	39.0 ± 3.0	17.03 ± 0.79	19.8 ± 0.0
Zn	6.65 ± 1.51	1.0 ± 0.7	1.06 ± 0.6	5	3.37 ± 0.09	2.48 ± 0.01	2.2 ± 0.0
Ca	1652.3± 4.02	-	-	2.090	2785.0 ±1.0	1839.1 ± 12.3	2100 ± 2.0
Mg	37.07± 0.11	322.5 ± 0.0	340.6 ± 2.8	480	382.0 ± 1.0	562.49 ± 9.07	313.0 ± 0.0
Na	163.90 ± 8.09	8.13 ± 0.6	40.78 ± 0.7	-	319.6 ± 6.0	307.65 ± 1.99	ND
K	304.5 ± 57.10	1845.0 ± 7.0	1817 ± 14.5	1620	1626.0 ± 1.0	NP	2250.0 ± 2.0
Ca + Mg	-	2016.5 ±22.6	2620.5 ± 5.6	-	-	-	-
Se	-	0.00955± 0.0	0.107 ± 0.0	-	-	-	-
Pb	-	0.355 ± 0.0	0.20 ± 0.0	-	-	-	-
As	-	0.0055 ± 0.0	0.28 ± 0.0 *	-	-	-	-
S	-	-	-	850	-	-	-
P	-	-	-	40	-	-	-

ND, not determined; NP, Not performed.

Phenolics and flavonoids are the most important antioxidants in *M. oleifera* leaf. Manguro and Lemmen (2007) have described thirteen phenolics from leaves of *M. oleifera* viz. Flavonol glycosides – Kaempferide 3-0 – (2", 3" diacetylglucoside, Kaempferide 3-O-(2"-O-galloylrhamnoside), Kaempferide 3-O- (2"-galloylrutinoside) -7-O-alpha-rhamnoside, Kaempferol 3-O-[beta-glucosyl-(1 - - >2)]-[alpha–rhamnosyl-(1→2)]-[alpha – rhamnosyl –(1- - > 4]-beta glucoside

-7O-alpha-rhamnoside, Benzoic acid 4-O-alpha glucoside, Benzoic acid 4-O- alpha –rhamnoside – (1 - - > 2) betaglucoside, Benzyldehyde 4-O-beta-glucoside, Kaemferol 3-O-alpha-rhamnoside, Kaempferol, Syringic acid, Gallic acid, Rutin and Quercitin3-O-beta-glucoside. Phenolics are larger in amount in leaf than that in flowers (Sankhallar and Vernekar (2016). They reported two new flavonoids, Biflavonyl and Myrcetin in flowers of *Moringa*.

Niziot-Tukaszewska *et al.* (2020) have also detected several polyphenols in *M. oleifera* such as Quinic acid, Chlorogenic acd, Gallic acid, Coumaroyl-quinic acid, Kaempferol-3-O-glucoside, Kaempferol-3-O-rutinoside, Rutin, Quercetin-acetyl-glucoside, Quercetin-acetyl-glucoside, Quercetin-malonytheoixside, Isoquercetin, Kaempferol-acetyl-glucoside and Quercetin. The plant provides a rich and rare combination of Zeatin, Quercetin, β-Sitosterol and Kaempferol (Biswas *et al.,* 2012). Numerous more phytochemicals may be seen in publications of Foidl *et al.* (2001), Yongbi (2010), Oluduroa *et al.* (2010), Amaglo *et al.* (2010), Sharma *et al.* (2011), and Bhalla *et al.* (2021).

Okumu *et al.* (2016) described phenolic content of aqueous and aqueous + methanol extracts of *M. oleifera* to be 34.42 ± 5.80 and 52.04 ± 3.12mg of Gallic acid equivalent per g of the dry plant material (mg $GAE.g^{-1}$), respectively, in Kenyan accession of *M. oleifera*. The total flavonoids content was 79.13 ± 13.04 and 366.09 ± 89.96 mg of Catachin equivalent per g plant material ($mgCE.g^{-1}$), respectively, in this Kenyan accession (Okumu *et al.* (2016). In this accession, ascorbic acid content was 2.02 ± 0.66 and 3.04 ± 2.06 mg of ascorbic acid equivalents per g dry plant material ($mg.AAE.g^{-1}$) when extracted in water and water + methanol. In South Indian accession of *M. oleifera* total phenol and total flavonoids were 627 ± 12.26 mg Gallic acid equivalent / 100g and 22.16 ± 1.54 mg Quercetin equivalent /g, respectively (Shanmgugavel *et al.,* 2018).

Table 4. Amino acids contents in leaf and seed of *Moringa* (Source: El-Shohaimy *et al.,* 2015; Ijarotimi *et al.,* 2013).

S. No.	Amino acids	El-Shohaimy *et al.* (2015) Leaf (mg / 100g)	Ijarotomi *et al*. (2013) Seeds (mg/100g)	Seed / leaf ratio
1.	Lysine *	63.13	312	4.93
2.	Histidine *	29.56	1930	66.4
3.	Valine *	62.34	1080	17.32
4.	Leucine *	94.36	3830	40.59
5.	Isoleucine *	46.98	4230	90.04
6.	Threonine *	48.35	3020	62.46
7.	Alanine	4.93	5160	1046.7
8.	Aspartic acid	13.76	1570	114.10
9.	Serine	3.13	3060	977.6
10.	Proline	1.86	2180	1172.04
11.	Glutamic acid	18.03	17870	991.1
12.	Glycine	2.31	2370	1025.97
13.	Arginine *	7.65	8280	1082.4
14.	Cysteine o	2.15	1680	781.4
15.	Tyrosine	2.03	1970	970.4
16.	Methionine*, o	0.43	310	720.9
17.	Phenylalanine	3.42	3270	956

*, Essential amino acids. o, Sulphur containg aminoacids.

El-Shohaimy *et al.* (2015) and Ijarotomi *et al.* (2013)) have reported amino acids contents in leaves and seeds of *M. oleifera*. Seed / leaf ratio of various amino acids as calculated from their data is presented in Table 4. Obviously seeds were richer in amino acids contents by many folds – more so in case of Alanine, Serine, Proline, Glutamic acid, Glycine, Arginine and Tyrosine. A comparative account of essential and non-essential amino acids in eggs, chicken breast, Ruifish, Pongas fish, Tilapa fish, soybean, rice, and wheat flour was made by Islam *et al.* (2021). *M. oleifera* profile was richer than many animal- and plant-derived sources, and more or less similar to that of egg and chicken breast. That's why it is reported to improve muscle strength and detoxify body (Basillo-Heradia and Gutierrez-Griialava, 2022).

The phytochemicals of medicinal interest in this species include flavonoids, glucosinolates and phenolic compounds, tannins, saponins, alkaloids, anthraquinones, glycosides, steroids etc. (Saleem, 1995; Manguro and Lemmen, 2007; Kasolo *et al.,* 2010; Amaglo *et al.,* 2010; Idris and Adamu, 2018) which may vary in concentration depending on the climatic conditions, the method of collection and processing (Coppin, 2008; Mukunzi *et al*., 2011). In addition, other compounds have been isolated from leaves, including different types of glycosides (Faizi and coworkers, 1998, 1997, 1995, 1994, Murakami *et al.,* 1998; Bennett *et al.,* 2003). Leaves also contain carotenoids, tocopherols and vitamins. The root bark is rich in two alkaloids: moringine and moringinine. It may, however, be mentioned here that very important compounds such as Niazirin, Niazirinin, and three mustard oil glycosides 4-{(4'-O-acetylalpha-L-rhamnosyloxy) benzyl isothiocyanate and Niaziminin A and Niaziminin B were first isolated by Faizi *et al.* (1994) from ethanolic extract of *Moringa* leaves. It was the first report of isolation of nitriles, and isothiocyanate and isothiocarbamates from the same plant. Isothiocyanate and thiocarbamate glycosides Niaziminin A and B showed hypotensive activity while nitrile glycosides were found to be inactive in this regard. Other important publications on phytochemicals of *M. oleifera* were by Faizi *et al*. (1997) regarding isolation and

structural elucidation of Niazidin (a novel glycoside) from pods and Faizi *et al.* (1998) regarding hypotensive constituents of Moringa pods.

Compounds of *M. oleifera* such as 4 (4'-O-acetyl- α-L rhamnopyranosyloxy) benzyl isothiocyanate, 4- (α-L-rhamnopyranosyloxy) benzyl isothiocyanate, Niazimicin, Pterygospermin, Benzylisothiocynate and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate (Glucomoringin), Benzyl isothiocyanate 4- (-L-rhamnopyranoxyloxy), Aglycone of Deoxy-Niaziicine (N-benzyl, S-ethylatioformate), 4-hydroxylmullein, Moryngyne, Niaziridin, Niazirin, and Isothiocyanatomethyl benzene (Fahey, 2005; Singh *et al.,* 2017; Pandey *et al*, 2019) are unique and responsible for the the properties of this species (Singh *et al.,* 2017; Pandey *et al*, 2019). Glucomoringin is the most abundant glucosinolates in Moringa to be as high as > 30mg/g DW in seeds and 20 mg/g DW in leaves (Baeza-Liménez *et al.*, 2022). The two alkaloids – glomoringin and glucosoonjnain are reported to vary by Chodur *et al.* (2018) in domesticated and wild types as evaluated in 36 accessions (21 domesticated and 15 wild types) collected from Pakistan, Madagacar, Kenya, Thailand, India, USA, Germany and South Africa. The wild types were organoleptically bitterer than domesticated types. There was substantially higher average concentration (75.29 µmol/g DW) of glucomoringin in domestic types than in wild types (18 µmol/g). On the other hand, average glucosoonjnain concentration (33.79 µmol/g) was significantly higher in wild types as compared to 1.6 µmol/g in domesticated types (Chodur *et al*., 2018).

Karthika *et al.* (2013) have isolated some 28 compounds from chloroform extract of *M. oleifera* leaves of which several were reported to be useful one way or the other as given below:

Isopropyl alcohol (antibacterial, antiseptic, antiesthatic, surfactant and Neurolytic), Ethyl alcohol (Antibacterial, antiseptic, antiesthatic, surfactant), Propylene glycol (Used in pharmaceutical), Lactic acid (Antibacterial agent, Food additive), Ethyl 2-hydroxypropanate (lactate) (Food additive), Phenethyl alcohol (antibacterial), Pyrocatechol (Pesticide, flavours, fragrances), 2, 3-Butanedione (DAS) Diacetyl (Flavours, Fragrances, alcoholic beverages), Linalool oxide (Antioxidant, antimicrobial), Trans-Linaloloxide (Antioxidant, antimicrobial), Heptanol (Cosmetics for fragrance), 1,2-benzenedicarboxylic acid, diethyl ester (CAS) ethyl phthalate (Plasticizer, antibacterial), Adenine (Antiviral, diuretic, antianemic), Palmitic acid (Antioxidant, pesticide, antimicrobial, lubricant) and 1,2-benzenedicarboxylic acid, bis (2-ethyl hexyl) ester (antibacterial).

Some 163 phytochemicals have been reported in Moringa by Lui *et al.* (2021) recently. Some of these compounds are unique to the Moringa family.

2) Vitamins contents of *M. oleifera*

The plant is rich in vitamins and minerals (Dahot, 1988) - even richer than several well-known sources as given below (Ganatra-Tejas *et al.*, 2012). This makes *Moringa* a valuable nutritional plant. Its edible parts have:

Vitamin A – 4X of carrot and 13 x of Spinach. Fresh leaves contain Vitamin A around 6.8 mg per and dried leaves contain 18.9 mg per 100g dried leaves (Hanuk, 2018).

Vitamin B – 4 X of meat; rich in Vitamin B2 (Riboflavin); Vitamin B3 (Niacin) – 50 x of Peanut; Vitamin C – 7X of oranges. Hanuk (2018) reported 220 mg of Vitamin C in 100g fresh leaves but only 17.3 mg in dried leaves of *Moringa*. Adenike (2014), however reported that sun-dried samples have higher contents of Vitamins C and E while samples dried at ambient conditions have higher concentration of P, K, Mg, and Vitamin A. Adenike (2014) thus concluded that *Moringa* leaves should be dried at ambient conditions due to higher retention of some essential minerals and Vitamins. Seeds are highly rich source of Vitamin E (751 ± 4.41 mg/100g plant material) as reported by Islam *et al*. (2021).

3) *M. oleifera* in human feeding

James and Zikankuba (2017) have described this plant as potential tree for nutrition security in Africa. NASA included it in list for space food. Isitua *et al.* (2015) advocated the use of *Moringa* leaves as food. Leaves have no trans fatty acids. The leaves of *M. oleifera* are used in preparing soup, salad and for making tea and other culinary uses (Stevens *et al.,* 2013). It is rated as super food (http://pharmaesy. in/blog/category/home-remedies/). It is used in soup, chocolate, biscuits and cakes, bread (adding 5% leaf powder in flour) and muffin (12% leaf powder) and several other food preparations (Islam *et al.,* 2021). Leaf-based food fights against malnutrition.

One year old *Moringa* tree is able to produce flowers and pods. Flowers are rich in Ca and K. Flowers may be mixed with batter and deep fried and eaten as highly nutritios special food (Halder and Kosankar, 2007). The cooked flowers have a taste like mushrooms. The flower nectar gives honey (Misra *et al.,* 2011).

The green seeds may be peeled off from outer coating and may be eaten as pea. In Malaysia, the green pods are used as ingredients of local curry varieties. From the roots sauces are prepared. The leaves show high content of vitamins, pro-vitamins and minerals (Palada and Chang, 2003). They also contain all essential amino acids including arginine and histidine, which are generally found in proteins of animal origin. The amino acids are very important

for children's growth. FAO promoted a program for the use of *M. oleifera* aimed at the children's population at malnutrition and the pregnant and lactating mothers (Fuglie, 2001). The *M. oleifera* oil is rich in oleic acid and tocopherols (Anwar *et al.,* 2005). Except for its lower content of linoleic acid, this oil shows similar chemical composition and physical properties as olive oil. It is used in salad seasoning in Haiti and other Caribbean islands (Foidl *et al.,* 2001) with no adverse effects, allergies or toxicity (Ghazali and Mohammed, 2011).

The oil cake of *Moringa* seeds is bitter in taste and known to contain anti-nutritional elements like haemogglutinins, glucosinolates, alkaloids and saponins (Farooq and Rashid, 2007).

The alkaloid moringinine in root bark is toxic and may cause nervous problems. Pterygospermin and alkaloid spirachin are nerve paralyzing (Halder and Kosankar (2007) and rated to be antibacterial (Das *et al.,* 1957). Addition of Moringa extract in butter at the rate of 800 ppm caused a decrease in product acceptance significantly as Moringa altered the organoleptic properties (Nadeem *et al*., 2013). Seed oil addition in ice cream was not effective in preventing the formation of free fatty acids (Nadeem *et al.,* 2016).

The composition of leaf flour of Moringa, its digestibity and antinutrition contents are presented in Table 5A as reported by Teixeira *et al.* (2014). The leaf flour has low contents of the antinutritional substances). Ferreira *et al* (2008), also reported low amounts of tannins (12 mg. $g^{-}1$) and absence of cyanogenic compounds in *M. oleifera* leaves. The content of oxalic acid was reported by Teixeira et al. (2014) to be much lower (10.5 mg/g) (Table 5A) than that in spinach (822 mg) by Franco (2005). Oxalic acid was 1.35 ± 0.03 g/ 100g DW of leaves of Moringa in Algerian accession (Zaini *et al.,* 2019). The trypsin inhibitors in Moringa were found much less active (Teixeira *et al.,* 2014) than those in soybean (107.22 trypsin Inhibitors units.mg^{-1}) as reported by Da Silva and Kerr (1999). Teixeira *et al.* (2014) compared their results on antinutritional substances to that in taro (reported by Pinto *et al.* (2001) and concluded that *M. oleifera* leaves can be eaten without nutritional damage. However, cyanogenic glucosides have been reported from Nigerian *M. oleifera* to be 3.3% in leaves and 2.60% in flowers (Okah and Carnelius, 2019) (Table 5B). The production of cyanogenic compouns appear to be environmentally regulated.

Table 5A. Composition of leaf flour, its in vitro digestibility and antinutrition substances (data from Teixeira *et al.,* 2014). Trees were located in Minas Gerais, SE Brazil).

S. No.	Substance	% concentration
1.	Crude Protein	28.7 *
2.	Fat	7.1
3.	Ashes	10.9
4.	Carbohydrate	44.4
5.	Ca	3.0 mg / 100g
6.	Fe	103.1 mg / g
In vitro disgestbility (%)		
1.	Casein (standard)	100
2.	Defatted flour	33.29
Antinutrition substances		
1.	Total tannins	20.60 mg/g
2.	Trypsin inhibitor	1.45 TUI/g
3.	Nitrate	17.0 mg/g
4.	Oxalic acid	10.5 mg /g
5.	Cyanogenic compounds	Absent
Others		
1.	B- carotene	161.0 µg/g
2.	Lutein	47.0 µg/g

*, Teixeira *et al. (*2014) opined that protein although in substantial amounts, but of low digestibility which suggests that *in vivo* studies should be carried out to assess their use.

Table 5B. Phytochemicals in leaves and flowers of Nigerian Moringa (Okah and Carnelius, 2019).

	Leaves (%)	Flowers (%)
Saponins =	5.00	3.20
Flavonoids =	5.42	7.12
Alkaloids =	5.36	1.55
Cyanogenic Glycosides =	3.30	2.60

Okah and Carnelius (2019) reported that saponins and flavonoids may be helpful in reducing blood cholesterol and prevention of cancer as suggested by some authors. The presence of cyanogenic glycosides should produce hydrogen cyanide in body but that could be easily detoxified by the body. This, obviously, needs to be studied in detail.

Moreover, Ojiako (2014) reported tannins to be 8.22% in leaves of Moringa of Anambra State, Nigeria- in quite higher concentration than that of Brazil plants (Teixeira *et al.,* 2014). This may probably be due to very much arid conditions of Nigeria.

4) Pharmaceutical and medicinal properties

Pharmacologically, Moringa is antioxidant, antidiabetic, anti-spasmodic, diuretic, ecbolic, anticancer, anti-microbial, anti-inflammatory, anti-hyperlipidaemic, anti-hyperglycemic, hepatoprotective, antiasthma, anthelmintic, anti-fertility, antipyretic, analgesic, anticonvulsant, renal protector, hypocholesteromic, anti-asthmatic, etc. (Das *et al.,* 1957; Shaw and Jana, 1982; Tahir *et al.,* 2017; Prithiviraj and Sumathy, 2021). And considered "Maha Oshidhi" (great medicine) in Ayurvadic system of medicine. It treats diseases (respiratory, gastrointestinal, inflammatory, cardiac, nutritional and skin diseases (Velazquez-Zavala *et al*., 2016; Agarwal and Mehta, 2008; Mahajan *et al.,* 2009). Razis *et al.* (2014) have described it as antitumour, anticancer and antifibrotic also. It is of potential benefit in Lactating mothers, menopause, depression, osteoporosis, rather functional in more than eighty diseases

(Mahmood *et al.,* 2010). Besides other uses, it is described as remedy of cholera, conjunctivitis, eye and ear infections, hysteria, Psoriasis, leukoderma, biliousness, semen deficiency, etc. (Das *et al.,* 1957; Shaw and Jana, 1982; Shamim *et al*., 2018). The traditional and pharmacological benefits of *M. oleifera* plant, described in many publications (to cite a few, Delaveau and Baiteau, 1980; Ramachandran *et al.,* 1980; Villasenor *et al.,* 1989 a and b; Makkar and Backer, 1996, 1997, 1999; Njoku and Adikwu, 1997; Fuglie, 1999; Rao et al., 2001; Fahey, 2005; Agbogidi and Ilondu, 2012; Stevens *et al.,* 2013; Ganatra-Tejas *et al.,* 2012; Shamim *et al*., 2018; Basillo-Heradia and Gutierrez-Grijalava, 2022 and several others), may be briefly summarized as follows:

Roots: Roots are reported to be antilithic, rubafacient, vesicant, carminative, antifertility, anti-inflammatory, stimulant in paralytic afflictions, acts as a cardiac / ciruculatory tonic, treating rheumatism, inflammations, articular pains etc. (Swati *et al.,* 2018). **Leaves**: Agbogidi and Ilondu (2012) described 75 therapeutic and prophylactic uses of *M. oleifera* from various sources. Medical use of leaf in Nigeria included curing of fever, treatment of ear infections and blood pressure (Stevens *et al.,* 2013). Swati *et al.* (2018) have reported application of its leaf poultice to sores, on temples for headache and in piles etc. **Flowers**: Throat infection, common cold, external sores, Anthelmintic, Antitumor, Rheumatism, tonic, Diuretic, hysteria and Abortion (Makkar and Becker, 1996, 1997, 1999; Ganatra-Tejas *et al.,* 2012). Flowers of *M. oleifera* are reported to be cholagogue, tonic, anti-oxidant, prescribed in cold phlegmatic condition (Rizvi, 1998; Rizvi and Ali, 2016) and epilepsy (Fuglie, 1999). **Seeds (Nuts**): Ganatra-Tejas *et al.,* (2012) described seed to be anthelmintic, useful in warts, Anti-tumor, Ulcers, rheumatism, arthritis, antispasmodic, goitrogen, and minerals / Vitamins deficiency. Seeds of *Moringa* are known to contain Vitamin A. *Moringa* juice is useful in conjunctivitis (Rao *et al.,* 1999). Seed extract of *M. oleifera* may be used as disinfectant (Bichi *et al.,* 1995). Seed extract of *M. oleifera* is antimicrobial (Eilert *et al.,* 1981). Frying quality of seed oil is said to be better in *M. oleifera* as compared to other vegetable oils (Abdulkarim *et al.,* 2007). Seeds are also used in perfume industry, cosmetics, lubricant, soap, oil and as body cream (Bhargave *et al.,* 2015). It is useful in pyodermia. It is anti-spasmodic, anti-schitosomes and antibacterial. **Fruits**: Anthelmintic, Skin Cancer, Anti-hypertensive, Diabetes, Cardio tonic, Joint Pain and dranunculiasis. **Seed oil**: Bladder disorders, hepatomegaly, prostrate function, antioxidant, purgative, dermal application, fungal /mycoses. **Exudates**: Dental Caries, Toothache, Syphilis, Typhoid, Earache, Fever, Asthma, Diuretic, Dysentery, Rheumatism, Headache, Abortifacient, Rubrafacient. ***In Vitro*:** Antibacterial and anti-fungal activity – *Bacillus cereus, B. subtilis, Escherichia coli, Pseudomonas aeruginosa, Streptococcus faecalis, S. aureus, S. epidermidis, Shigella shinga, S. sonnei, Aspergillus niger, Candida albicans, Microspermum canis, Fusarium solani, Rhizopus solani, Yeast dermatophytes and Epidemophyton xoccosum. M. oleifera is active against helminths – Trichophyton rubrum, T. mentagraphytes.* Compounds like 4-(-L-rhamopyanosyloxy) benzyl iso-thiocyanate, 4- (-L- rhamopyanoxsyloxy) benzyl-glucosinolate and Pterygospermin are considered to be responsible for antibiotic activity.

Table 6. Antioxidant activity of *M. oleifera* on the basis of various antioxidant parameters.

Antioxidant Parameters	Methanol-Water Extract	Hydrophilic Extract	Lipophilic Extract
TEAC (µmol TE/ 100g FW leaves	6208 ± 206	1426 ± 72	341 ±16
DPPH (µmol TE/ 100g FW leaves	3055 ± 140	854 ± 64	125 ±10
FRAP (µmol TE/ 100g FW leaves	3962 ± 297	635 ± 22	580 ± 50
ORAC (µmol TE/ 100g FW leaves	10805 ± 690	6683 ± 204	201 ± 11
TPC (mg GAE / 100g FW leaves	504 ± 28	145 ± 6	63.5 ± 4.9
Tobart index	0.2058	0.2423	0.2416

Source: Gonzalez-Romero *et al.* (2020). Abbreviations: TEAC = Trolox equivalent antioxidant capacity; DPPH = 2, 2-diphenyl - 1-picril-hydrazyl hydrate; FRAP = Ferric ion reducing antioxidant Power; ORAC = Oxygen radical Absorbance capacity; TPC = Total Polyphenol content by Folin Ciocalteu reagent. TE = Trolox equivalent per 100g FW. In each case the M. oleifera activity was the highest.

5) Antioxidant property

Moringa is highly rich in antioxidants, a most probable reason of its health benefits. The flavonoids act as antioxidants and enhance the effects of vitamin C (Korkina and Afanas'ev, 1997). The Flavonoids are also effective antimicrobial and have the ability to bind with extra-cellular and soluble proteins and complexes of bacterial cell walls. Phenolics and flavonoids can form chelate complexes with metal ions, thereby getting easily oxidized by donating electron to scavenge free radicals (Siddhuraju and Becker, 2003; Sreedam *et al.,* 2010). Higher phenolic concentration in *M. oleifera* is correlated with increased antioxidant activity of Moringa (Kostyuk *et al.,* 2001; Borneo *et al.* (2008).

M. oleifera possess highly potent antioxidants in leaves and seeds (Unuigbe *et al.,* 2014; Niziot-Tukaszewska *et al.,* 2020). According to Pakade *et al.* (2013) *M. oleifera* contains more than 40 natural antioxidants and well known for its effects in elimination of free radicals. Gonzalez-Romero *et al.* (2020) have investigated antioxidant potential

of *M. oleifera* grown in Andalusia (Spain) and compared it with 28 types of salad plant or their leaves (green lettuce, red lettuce, beet leaves, chand, Chinese cabbage, curly green cabbage green leaves, curly green cabbage white leaves, endive, escarole, green cabbage, Green lettuce plants, iceberg lettuce plants, kale, lamb's lettuce, lollo rosso lettuce (mix salad (white cress + lamb's lettuce + lollo rosso salad), Oak leaf lettuce, red Cabbage, red chickory, red lettuce plants, red lettuce sprouts, rocket salad, roman rettuce salad, spinach, spinach sprouts, turnip green (tops) and water cress) on the basis of five antioxidant parameters. It was found to be the best antioxidant plant always at the first rank in antioxidant efficiency – much higher in activity than the test species. The antioxidant activity of *M. oleifera* is given in Table 6. The methanol-water extract showed the maximum activity. The leaves were rich in total phenolic content, carotenoids, total flavonoids and chlorophylls. It was concluded by Gonzalez-Romero *et al.* (2020) that addition of *M. oleifera* leaves to the existing range of fresh-cut salad foods would increase their antioxidant content by six times. Sajid *et al.* (2020) showed that seed oil of *M. oleifera* is antioxidative hypoglycemic agent capable of improving the other clinical conditions as well related to oxidative stress of diabetes mellitus such as hepatic, renal and pancreatic functions in alloxan treated rats. Luqman *et al.* (2012) have also shown the leaf and fruit extracts of *Moringa* to be potent antioxidant. In a sample from Mardan (Pakistan), Iqbal and Bhanger (2006) had analyzed samples from Balakot, Chakwal, Jamshoro, Nawabshah and Mardan and found that the antioxidants content of *M. oleifera* was higher in the month of December or March and least in Jume depending upon the location i.e., seasons and agro-climatic location influence antioxidant activity. Atawodi *et al.* (2010) suggested the plant's high polyphenol content to be related to antioxidant activity. Sidhuraju and Becker (2003) also found variation in antioxidant properties of *M. oleifera* with solvent extraction of phenolic constituents from three different agro-climatic origins. According to Olaoye *et al.* (2021) environmental parameters such as annual precipitation, minimum and maximum temperatures and soil type influence the antioxidant activity of *M. oleifera*. The flavonoids, total phenolic content, saponins, lipid peroxidation inhibition, tannins contents varied with samples locations (21 accessions) in Southwestern States of Nigeria. Percent antioxidant activity as DPPH scavenging activity and nitric oxide scavenging activity was directly related with the dose (positive dependency). Some very important antioxidants in Moringa are investigated and discussed in Bennet *et al.* (2003), Turner *et al* (2015), Amara *et al.* (2021) etc. Most of the health benefits of Moringa appear to be due to its antioxidants and their richness.

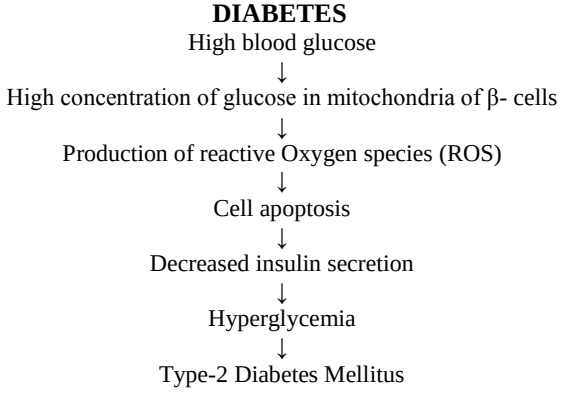

Fig. 1. Metabolic sequences of high glucose leading to Type-2 Diabetes in man. *Moringa oleifera* prevents the apoptosis of β – cells due to its antioxidant contents. Which combine with the ROS and prevent the cell damage. Fig. source: Gopalakrishnan *et al.* (2016).

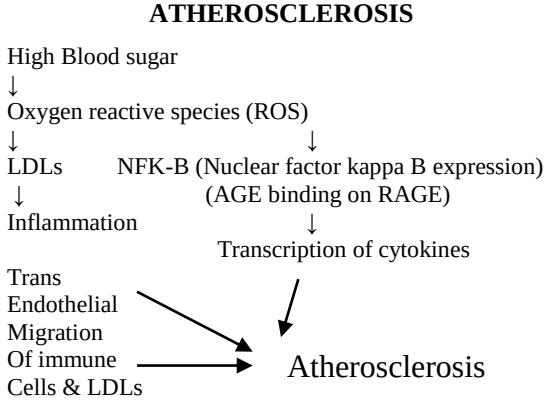

Fig. 2. Diabetes leading to atherosclerosis. Abbreviations: AGE, Advanced glycelated end products; RAGE, Receptors for AGEs on surface of cells. *Moringa* can prevent atherosclerosis by scavenging ROS and preventing formation of AGE and LDLs. Seen in Gopalakrishnan *et al.* (2016).

Antidiabetic effects of *Moringa* have been reported in literature (Kaneto *et al*., 1999; Mbikey, 2012; Cerf, 2013; Al-Malki and El Rabey, 2015; Villarreal-Lopez *et al.*, 2018). There were significant hypoglycemic effects of *Moringa* in diabetic rats and no lethal dose was discovered. Isothiocynates rich extract of foliage is reported to act against insulin resistance (Waterman *et al.*, 2015). Chumark *et al.* (2008) have discussed anti-atherosclerotic effects of *M. oleifera*. Ezeigbo *et al.* (2016) have demonstrated more hypoglycemic effect of aqueous extract of leaves of *M. oleifera* than its ethanol extract, after 14 days of administration in alloxan-induced diabetic Wistar rats. There was 45.2 and 33.7% reduction in blood glucose for aqueous and ethanol extract, respectively whereas the reference drug insulin had 58.7% reduction. Diabetic and atherosclerotic pathways in diabetics have been elaborately discussed by Gopalakrishnan *et al.* (2016) – (Fig. 1 and 2). *Moringa* prevents diabetes by scavenging ROS and thus

prevention of apoptosis of β-cells due to its anti-oxidative contents. Similarly, Moringa can prevent atherosclerosis by scavenging ROS and preventing formation of LDLs and advanced glycelated end products (Aronson and Rayfiels, 2002; Wright *et al.*, 2006; Chumark *et al.*, 2008; Mbikey, 2012; Gopalakrishnan *et al.*, 2016). Rutin, a phenolic of *M. oleifera* is reported to be antihyperglycaemic and antioxidant (Kamakkannan and Prince, 2006).

Table 7. List of susceptible organisms to *Moringa oleifera*. (Source: Xiao *et al.*, 2020).

S. No.	Organisms	Active Plant component
	Bacteria	
1.	*Aeromonas cavie*	Leaf
2.	*Bacillus cereus*	Seed
3.	*B. megaterium*	Bark
4.	*B. subtilis*	Leaf
5.	*Citrobacter freundii*	Bark
6.	*Enterobacter aerogenes*	Leaf and seed
7.	*Enterococcus faecalis*	Leaf
8.	*Escherichia coli*	Leaf, seeds and pods
9.	*Klebsiella pneumonia*	Leaf
10.	*Mycobacterium phlei*	Leaf
11.	*Proteus mirabilis*	Seed
12.	*Providencia stuartii*	Leaf
13.	*Pseudomonas aeruginosa*	Leaf and seed
14.	*Salmonella typhimurium*	Pod
15.	*Serratia marcescens*	Leaf and seed
16.	*Staphylococcus aureus*	Leaf, seed, pods and bark
17.	*S. epidermidis*	Pods
18.	*S. pyogenes*	Leaf and seeds
19.	*Vibrio cholerae*	Leaf and flowers
20.	*V. mimicus*	Flowers
21.	*V. vulnificus*	Flowers
22.	*Yersinia enterocolitica*	Seeds
	Fungi	
1.	*Aspergillus flavus*	Leaf and seeds
2.	*Basidiobolus haptosporus*	Leaf
3.	*Cryptococcus neoformans*	Seeds
4.	*Epidemophyton floccosum*	Leaf and seeds
5.	*Microsporum canis*	Leaf and seeds
6.	*Penicellium aurantiogriseum*	Leaf
7.	*Trichophyton mentagrophytes*	Leaf and seeds
	Viruses	
1.	Epstein- bar virus	Leaf and seeds
2.	Equine herpes virus	Leaf
3.	Foot and Mouth disease	Leaf
4.	Hepatitis virus	Dry powder
5.	Herpes simplex virus	Leaf
6.	Human immunodeficiency virus	Leaf
7.	Infectious bursal disease	Leaf
8.	Rhinovirus	Leaf
	Parasites	
1.	*Brugia malayi*	Gum
2.	*Cryptosporidium parum*	Leaf
3.	*Dracuaculiasis*	Leaf
4.	*Haemonchus*	Seeds
5.	*Helminths*	Seeds
6.	*Hymenolepis nana*	Leaf
7.	*Leishmania donovani*	Flowers
8..	*Plasmodium*	Seeds
9.	*Schistosomes*	Flowers
10.	*Trypnosoma brucei*	Aerial parts

7) Antimicrobial activity

Aqueous extract of *M. oleifera* seeds have substantial potential against pathogenic microscopic organisms e.g., *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* in dose dependent manner (Saadabi and Abu, 2011; Garga *et al.*, 2019). Aqueous extract was exceptionally inhibitory to *Mycobacterium phlei* and *B. subtilis* (Eilert *et al.*, 1981). *Moringa* seed oil has antifungal activity against *Rhizophus solani* and *Fusarium solani* (Chuang *et al.*, 2007). Ayirezang *et al. (*2020) reported that at 100 mg/ mL of methanol extract, the leaves gave wider zone of mycelia growth inhibition against *Aspergillus flavus* and *A. niger* (Food spoilers) – more than the seed extract It may be mentioned that the activity was lower than that of sodium benzoate. The minimal inhibition concentration of the extracts was more active at 25 mg / mL. Issa *et al.* (2021) have reported ethanolic extract to be inhibitory and *S. aureus* to be the most sensitive to aqueous and ethanolic extract. N-hexane extract exerted no activity. MIC of Aq. Extract was 60mg/mL for *S. aureus*, 80 mg/mL for *P. aeruginosa* and *E. coli*. The MIC of ethanol extract for 60 mg/mL for *S. aureus*, 80 mg/mL for *E. coli* and 100 mg/mL for *P. Aeruginosa* as indicated through agar well diffusion method. *Moringa* leaf extract compared favourably to nystatin, streptomycin and gentamicin (Oladeji *et al.*, 2020). It showed potency against *Klebsiella* sp. *P. aeruginosa*, *Trichoderma* sp., *Aspergilllus flavus*, *Bacillus cereus*, *S. pneumoniae*, *Candida* sp. and *E. coli*. Antibacterial activity of Moringa leaf against *S. aureus* and *E. coli* is also reported by Malhotra and Mondal (2018) in their *in vitro* studies and speculated it due to tannins, flavonoids, glycosides, terpenoids, phenols, etc. Abalaka *et al.* (2011) reported that chloroform extract showed remarkable activity against *E. coli*, *Salmonella typhi* and *P. aeruginosa.* Ethanolic and methanolic extracts of *M. oleifera*, collected from salt range of Thal desert of Pakistan and dried under shade, were found to be effective against *Aspergillus fumigatus*, *A. niger* and *Candida albicans*. Antibacterial effects of *M. oleifera* on *E. coli*, Streptococcus pneumoniae and Staphylococcus aureus have been reported by Idris and Abubakar (2016) from Nigeria.

Xiao *et al.* (2020), based on several references, have presented a long list of susceptible organisms (bacteria, fungi, viruses and parasites) as given in Table 7. Crude ethanolic extract from flowers and callus of *M. oleifera* have also exhibited antibacterial activity (Talreja, 2010).

8) Neuroprotective effects

In rat model, Moringa has been shown to have a neuro-protective effects against brain damage and decline in memory (Igado and Olapade, 2016). The data of Amara *et al.* (2021) showed that *Moringa* extract prevents oxidative damage by lowering reactive oxygen species (ROS) formation, restoring mitochondrial respiratory chain complex activities, and, in addition, by modulating the expression of vitagenes. *Moringa* extract also protected mitochondria from apoptosis. Alqahtani and Abasher (2021) reported the potential neuroprotective effect of *M. oleifera* extract against lead-induced brain toxicity. The extract stimulated detoxifying enzymes. Ganguly and Guha (2008) have reported *M. oleifera* to protect against Alzheimer's disease by altering brain monoamine levels and electrical activity. Mechanisms triggering neurodegeneration is unknown but has largely been suggested due to oxidative stress (Calabrese *et al*., 2007). Moringa acts against neurodegeneration probably due to its polyphenolic contents and other antioxidants (Luqman *et al*., 2012).

9) Nematicidal activity

The extracts of leaves and seeds of *M. oleifera* were reported by Oluwatayo *et al.* (2019) to decrease *Meloidogyne incognata* population, reduce root galling as well as the nematode reproduction resulting in the yield of tomato varieties (UC28B, Roma VF and Riogrande). Leaves extract used at 5% concentration at the rate of 40 mL per pot significantly reduced *M. incognata* population in association of sugar beet CV. Gazelle (El-Nagdi and Youssef, 2015). Nematicidal and antifungal activity of leaves and seeds extracts was also reported by Olajide *et al.* (2018) when used in cucumber (*Cucumis sativus*), *M. incognita* and soil borne fungi such as *Phytophthora* sp., *Rhizopus* sp. *Penicillium* sp. *Aspergillus niger*, *A. parasidicus* and *A. flavus*. All fungi were *in vitro* differentially inhibited by seeds and leaves extract, but Seed extract was inhibitorier on *Phytophthora* sp. and leaf extract was inhibitorier on *A. flavus*. A variety of cucumber "marketmore" was higher in performance of vegetative growth than variety cucumber Roma-vf. Cold pressed seed oil of *M. oleifera* was reported to be effective against *M. incognata*. Compared to free eggs, egg masses were more sensitive to the oil as the second stage juveniles.

Both alone or combined application of *Trichoderma harzianum* and *M. oleifera* has been reported to cause significant reduction of hatching of eggs and caused higher juvenile mortality of *Meloidogyne javanica* associated with eggplant under greenhouse conditions. Treatment against *Meliodogyne javanica* with *T. harzianum* combined with *M. oleifera* was more effective both in vitro and under field conditions (Murslain *et al.,* 2014). A possible mechanism of effectiveness of plant extracts or seed oil is considered to involve disruption of cell membrane of the nematodes (Kayani *et al.,* 2012). The studies are, however, not conclusive (Refaat *et al.* (2020) who opined that there is a need for further research to elucidate the nematicidal activity of seed oil under greenhouse conditions and moreover the physiological mechanism in action.

10) Immunity against viruses

Kurokawa *et al.* (2016) reported that aqueous extract of foliage builds immunity agist herpes ans simple virus type 1 (HSV 1).

11) Moringa as breast-milk augment

M. oleifera is reported to augment breast milk in lactating women (Singh *et al.* (2021).

12) Antitumour and anticancer property

Moringa leaves have been reported to show antitumor activity and niazimicin has been proposed to be a potent chemo preventive agent in chemical carcinogenesis (Guevara *et al.,* 1999). The seed extracts have also been found to be effective on hepatic carcinogen metabolizing enzymes. Bharali *et al.* (2003) have reported that a thiocarbamate from the leaves of *M. oleifera,* exhibited inhibition of tumor promoter induced Epstein–Barr virus activation. Antitumor and anticancer properties of Moringa have been reported by Murakami *et al.* (1998) and Razis *et al.* (2017). Brilhante *et al.* (2017) described two very important *Moringa* bioactive glycosides (Niazimicin and Niazinin) in their comprehensive review based on 113 references. Earlier Goevara *et al.* (1999) presented evidence on the function of niazimicin present in *M. oleifera* from Philippines as an inhibitor against the two-stage mouse tumourigenesis. It decreases the proliferation and invasion of cancer cells (Jung, 2014). Crude aq. extract of Moringa (Tiloke *et al.,* 2013) and ethanolic and methanolic extracts of Moringa foliage are reported to be antiproliferative and inhibitory to cancer cells (Lea *et al.,* 2012).

13) Anti-Colon-Cancer

Shousha *et al.* (2019) reported that silver nano-particles (AgNPs) into *M. oleifera* extract enhanced the *in vitro* antioxidant efficiency. Polyphenolic compounds and their scavanging against free radicals eas effective against the growth of colon cancer cells. A literature survey on the subject is presented by Christiano and Smarandache (2019) and they rated it as possible anti-cancer treatment with further future research.

14) Breast and colo-rectal cancers

Al-Asmari *et al.* (2015) reported anti-malignant properties of *M. oleifera* leaves collected from the Saudi Arabian region. The survival of breast and colorectal cancer cell lines was significantly reduced by extracts of leaves and bark. Previously, Eugenol (present in *M. oleifera* bark) was shown to be active against breast cancer (Al-Sharif *et al.,* 2013). The role of Eugenol in cell apoptosis was reported by Lacroix *et al.* (2006). According to Charoensin (2014) *M. oleifera* leaves possess antioxidant activity as well as cytotoxic and chemopreventive properties, *in vitro*, in three types of cancer cell lines: hepatocarcinoma, colorectal adenocarcinoma and breast adenocarcinoma.

15) Hypocholesterolaemic activity

Ghasi *et al.* (2000) reported hypocholesterolaemic effects of crude leaf extract of *M. oleifera* in Wistar rats fed with high-fat diet. B-sitosterolin in seed oil is considered to have a role in cholesterol metabolism by lowering the low-density lipoprotein (LDL) cholesterol in blood (Baeza-Liménez *et al.* (2022)

16) Hemoglobin promoting activity

Safitri and Retnaningsih (2021) reported significant increase in hemoglobin in pregnant rats due to *Moringa* leaves probably due to high iron content in leaf.

17) Anti-urolithiasis effect

Karadi *et al.* (2008) have shown anti-urolithiatic effects of *M. oleifera* root bark.

18) Testicular damage and fertility of females

Nayak *et al.* (2020) reported that administration of *M. oleifera* ethanolic extract of leaves mitigated cyclophosphamide-induced testicular toxicity by improving blood and intra-testicular hormonal milieu as well as modulating the expression of genes pertaining to Sertoli and spermatogonial cells in adult Swiss albino mice. Previously, Nayak *et al*. (2016) had earlier reported that combining *M. oleifera* extract with cyclophosphamide increased the sperm density, motality and reduced head defect and DNA damage. Aq. extract of Moringa is also reported to protect against Oxidative DNA damage (Singh et al., 2009). According to Albasher *et al*. (2021) *M. oleifera* extract ameliorated testicular damage induced by lead acetate. It is a good treatment to lead toxicity. Moringa may alleviate erectile dysfunction (ED) in mice due to polyphenols which improve nitric oxide production and testosterone level. Dr. Shahzad Basra (video on youtube) reiterated that it may overcome ED due to its contents of l-citrulline, l-arginine, and Co-enzyme Q-10, Zn and Se. Its aqueous extract (Zade *et al.,* 2013) in male albino rats and hexanoic extract in male mice (Musmusculus) (Cajuday and Pocsidio, 2010) are reported to increase sexual desire and sperm count. It may improve fertility in female rats.

19) Anti-fertility activity

The root extract promotes inhibition of the uterus for implantation of the fertilised eggs (Prakash *et al.* (1987). The aqueous and 90% ethanol leaf extracts affected the foetal development and completely aborted implantation (Shukla *et al.,* 1988; Nath *et al.,* 1992). A high dose of the root extract (600 mg/kg) has anti-progestational activity in rats (Shukla *et al*., 1988). It also reduced the protein concentration for the formation of the uterus (Prakash *et al.,* 1988).

20) Antihypertensive

Juice of Moringa influences blood pressure (Dahot, 1988). The leaves contain mustard oil glycosides, thiocarbamate glycosides and nitriles that may help in bringing down blood pressure (Faizi *et al.,* 1995).

21) Cosmetic use

The oil derived from *M. oleifera* seeds is widely utilized in cosmetic (Caceres and Lopez, 1991). Leaf extract is rich in phenolic compounds. Niziot-Tukaszewska *et al.* (2020) reported that up to 5% extract concentration of leaf shows positive effects on cell metabolism and may contribute to reduction of oxidative stress in cells. Its addition in cosmetics may improve their safety and reduce skin irritation.

22) Disinfectant

Seed extract of *M. oleifera* has potential of a disinfectant (Bichi *et al.,* 1995).

23) Biopesticide

Fuglie (1999) described Leaves as possible source of Biopesticide.

24) Anti-allergic activity

Abd Rani *et al.* (2019) reported anti-allergic activity of Moringa extracts by in both the early and the late phases of allergic reactions presumably due to the presence of several active compounds in various plant parts. Such compounds include - Ethyl-(E)-undec-6-enovate; 3, 5, 6 –trihydroxy2-(2, 3, 4, 5, 6 –penta hydroxyphenyl)-4H-

Chroman-4-one; Quercetin; Kaempferol; B-Sitosterol-3-O-glucoside; Oleic acid; Glucomoringin; 2, 3, 4 – trihydroxybenzaldeyde and Stigamasterol

25) Cardiovascular disorders

The data collected on rats (Male Wistar Kyoto) support the use of orally administered *M. oleifera* seeds in diet against cardiovascular disorders associated with oxidative stress and hypertension (Randriam Boavonjy *et al.,* 2017). Its extracts alone or in combination with extracts from other plant like *Peristrophe bicalyculata* is reported to act against diabetes in alloxan-induced diabetic winstar rats and potential efficacy in CVDs (Iwara *et al.,* 2014).

26) Diarrhea

The antispasmodic and antimicrobial activities of roots have been reported for treatment of diarrhea (Cáceres *et al.,* 1992).

27) Anti-obesity

Methanolic extract of *M. oleifera* has been reported to be beneficial to the weight management (Bais *et al.,* 2014) of fat induced obese rats. Metwally *et al.* (2017) have concluded that it is reasonable to assume that antiobesity, Antiatherogenic and antidiabetic properties of *M. oleifera* are achievable and this plant could be a good therapeutic candidate in this respect. In high fat-induced rats significant amelioration of obesity was considered as a result of their antioxidant potential. Nahar *et al.* (2016) have reported that consumption of *M. oleifera* may modulate obesity in rats when administered with dose of 50 mg/ day/ rat orally for 35 days with high fat diet. The anti-obesity activity of *M. oleifera* was considered by Redha *et al.* (2021) to be owing to the improvement of lipid profile, body mass and significant regulation of genes associated with adipogenesis, glucose uptake, insulin resistance and hormones such as leptin, vaspin, resistin and insulin.

28) Diuretic activity

Administeration of seed infusion has been reported to show diuretic activity and inhibition of carrageenan-induced edema (cáceres *et al.,* 1992). In swiss albino rats, alcoholic extract of *M. oleifera* leaves produced dose dependent diuretic action with doses of 50, 100 and 200 mg/kg body weight (Tahkur *et al.* 2016).

29) Immune Disorders

M. oleifera is active in immune disorders (Xiao *et al.,* 2020). It is found to stimulate immune system (Sudha *et al.,* 2010).

30) Antinociceptive and anti-inflammatory effects

Ethanol extracts of *M. oleifera* leaves can be a potential source of anti-inflammatory agents compared to acetone extract and the standard drug (Padmalochana, 2018). Sulaiman *et al.* (2008) evaluated the antinociceptive and anti-inflammatory effects of the aqueous extract of the leaves of *M. oleifera* in laboratory animals. The extract exhibited significant antinociceptive activity and they confirmed the traditional uses of *M. oleifera* in the treatment of pain and inflammation. Cáceres and Lopez (1991), Cáceres *et al.* (1992), Ezeamuzzle *et al.* (1996), Guevara *et al.* (1996), Mehta and Agrawal, 2008, Ndiaye *et al.* (2002), Mahajan and Mehta (2008), etc. are some of the important publications on the subject. Alkaloids of Moringa have activity similar to that of ephedrine and may be useful in therapy for asthma. Moringine shows bronchiole relaxation activity (Kirtikar and Basu, 1975).

31) Analgesic Activity and Local Anaesthetic Activity

Alcoholic extract of seeds of *M. oleifera* exhibited potent analgesic activity (Sutar *et al.,* 2008). The root bark has also exhibited significant local anaesthetic activity (Bandana *et al.,* 2003).

32) Anti-ulcerogenic

Protection against gastric ulceration was significantly evident in rats which were treated with indomethacin to produce ulceration. Protection was in dose dependent manner of the leaf extract (100-400 mg/ kg BW) possibly due to tannins and flavonoids (Dahiru *et al.,* 2006). Cáceres *et al.* (1991) have asserted that the presence of flavonoids in *Moringa oleifera* should offer some protection in ulcer development.

33) Anti-asthmatic effects

Agarwal and Mehta (2008) reported that alkaloids present in *M. oleifera* act like ephedrine and may treat asthma. These alkaloids unwind bronchioles. Bronchial asthma has successfully been treated utilizing seed kernel of Moringa and furthermore enhanced respiratory capacities (Agarwal and Mehta, 2008).

34) Hepatoprotective

Hepatoprotective effects of hydroethanoloc extract of Moringa foliage are reported by Fakurazi *et al.* (2012) and Ujah *et al.* (2013). Pari and Kumar (2002) have reported hepatoprotective activity of *M. oleifera* ethanolic extract in anti-tubercular drug-induced (isoniazid, rifampicin and pyrazinamide) liver damage in rats. Medicinal properties are attributed to the bioactives present in Moringa. However, the underlying mechanisms remain unclear (Ma *et al.*, 2020).

35) Gum exudates of *M. oleifera*

The gum released from stem of *M. oleifera* is initially white in colour which on long exposure turns to reddish brown or brownish black in colour (Sonica *et al.*, 2020). Gum exudates of the *Moringa* tree are of immense medicinal importance in treatment of some diseases like asthma, dysentery and intestinal cancer (Gupta *et al*., 2018). It is useful as stabilizer, binder, mucoadhesive (Sonica *et al.*, 2020). It is nutritive – contains vitamins B_2, B_6 and C, Mg, Ca, Fe, proteins, carotenoids and provitamin A (Mehta *et al.*, 2011b).

36) Seed oil quality

Seed oil of *M. oleifera* is light yellow in colour and has nutty flavour. It is up to 40.39% of the seed in Sindh accession of the plant (Anwar and Rashid, 2007). According to Anwar *et al.* (2007), the composition of sterol in Moringa oil comprises β-sitosterol (major component) and also stigmasterol, campesterol and D5-avenasterol. Thermal stability of Moringa oil is higher than soybean, sunflower, canola, cotton seed oils. It can be used in the formation of vanaspati, margarine, bakery shortening, as salad oil, cooking oil, for frying of potato chips and as frying fat in industry and restaurants (Anwar *et al.*, 2007; Nadeem and Imran, 2016). It is high in oleic acid content and may be new source of edible oil. According to Barkat and Ghazal (2016) seed oil contains predominantly oleic acid (Table 8) – similar to olive oil. A seed ointment had an effect similar to neomycin against *Staphylococcus aureus* pyodermia in mice. Seed oil of a sister species, *Moringa concanensis,* collected from Tharpakar, also has oleic acid in predominace (68%) and palmitic acid 11.4% (Manzoor *et al.*, 2007).

37) Seed cake

Proteins may be extracted from the seed cake for water purification. The addition of pressed cake in diet of sheep with soybean has been shown to boost ruminal fermentation and weight gain in animals directly proportional to the supplied dose (Ben Salama and Makkar, 2009).

38) Seeds as fertilizer

Seeds may be used as fertilizer (Martin *et al.*, 2013). The seed husk may be used in ethanol production.

39) Bio-preservation

Leaf extract of *M. oleifera* has some potential in bio-preservation of giant freshwater prawn, *Macrobrachium rosenbergii* (Karim *et al.*, 2018). Ayirezang *et al.* (2020), have opined that *Moringa* extracts may be used as bio-preservation agents for prolonging the shelf life of food products.

Table 8. Fatty acid composition (%) of seed edible oil (Source: Barkat and Ghazal, 2016) from Egypt. The trees were grown in three different areas.

Fatty acid	Localities of Egypt			
	M. Asuit	M. Oraby	M.Monofya	Olive oil*
Palmitic acid	6.09	5.66	6.44	7.5-20
Palmitolic acid	1.80	1.43	1.92	3.0-3.5
Margaric acid	0.08	0.09	0.09	0- 0.3
Heptadecanoic acid	0.10	0.06	0.06	0- 0.30
Stearic acid	7.94	4.79	7.12	0.5-5.0
Oleic acid*	73.30	79.58	73.51	55.0-83.0
Linoleic acid	0.59	0.58	0.59	3.5-21.0
Linolenic acid	1.7	0.15	0.17	0.0-1.0
Arachidic acid	5.1	1.57	4.71	0.0- 0.6
Gadoleic acid	1.18	3.16	2.74	0.0- 0.40
Behenic acid	3.62	2.89	2.62	0.0- 0.20

*, Egyptian standard (2005 for olive oil).

40) Biodiesel

Biodiesel production from less familiar and unconventional oils including Jatropha, Moringa, Pongamia, and tobacco have received greater attention in recent years (Rashid *et al.* 2008; Kivevele and Huan 2015). A survey conducted on 75 Indian plant species have concluded that fatty acid methyl esters (FAMEs) of Moringa seed oil

meet all the main specifications of biodiesel standard of Germany, Europe, and the United States (US) (Azam *et al.* 2005). *M. oleifera* seeds contain 33–41 % (w/w) oil, known as ‘‘ben oil’’. It possesses significant resistance to oxidative degradation (Rashid *et al.* 2008). Moringa seeds oil is a potential candidate for biodiesel production (Rashid *et al.,* 2008). Azad *et al.* (2015) reiterated the prospect of *M. oleifera* seed oil as a sustainable biodiesel.

41) Developing effervescent granules of *Moringa*

Effervescent granules were developed from leaves of *M. oleifera* by Rani *et al.* (2021) with the following formula which was evaluated best through organoleptic and sensory examination – acceptable in terms of colour, taste, aroma and texture.

Effervescent granule formula:
Moring dry leaves powder 2g + Citric acid 2.3g + $NaHCO_3$ 2.70g +Xanthan gum 0.5g + sucrose 10 g + Stevia 1.6 g + Sodium benzoate 0.05 g + Poloxamer188 0.125g + Meltodextrin 2.5 g + Melon flavour 2.075 g + Strawberry flavour 1g + Pure water 20 mL.

The Plant was harvested from Bogo village, Boganegoro, East java. The leaves were sorted, washed, drained and dried by aerating in the shade at 25-35^{o}C and humidity 50% until moisture was 10%. Wet granulation method was employed with above formula and granules were sieved through mesh No. 10 sieves and dried in oven at 50% till moisture was 3-5%.

42) Moringa and hair loss

In vitro application of Moringa at the dose of 25 to 100 µg/ mL, provided significant protection from Gentamicin-induced hair cell loss. With dosage above 100 µg/ mL it provided near complete protection. Assay of Moringa extract by Broderick *et al.* (2021) demonstrated suppression of ROS, preservation of cytochrome oxidase activity, reduction in Caspase production and prevention of cell apoptosis *Moringa* extract protected against aminoglycoside -induced hair cell death also (Broderick *et al.,* 2021).

43) The psychological and spiritual properties of *M. oleifera*

Traditional therapeutic, psychological and spiritual effects of *M. oleifera* according to the principles of traditional Ayurvedic and Chinese medicine systems are discussed by Meireles *et al.* (2020). According to them, *M. oleifera* penetrates the deep layers of body tissues and particularly into the bone marrow. It purifies blood, removing impurities, toxins, parasites and metabolic wastes. *Moringa oleifera* strongly influence personality. Kaur *et al.* (2015) suggested it to have anti-depressive and anxiolytic effects. Drue and Minor 2018) considered it to be an adaptogenic and anti-stress plant. According to ancient ayurvedic physicians, it contributes to the feeling of certainty, courage and fearlessness. Its root is known to enhance feelings of serenity and balance in adverse uncertain situations.

The seeds of the plant were used as a remedy for depression in ancient India. The seeds were reported tonifying and were believed to renew the spirit and reinvigorate the body as well as the mind and emotions (Warrier *et al.,* 2010). The flowers were believed to be benefcial in traumatic memories. They are said to encourage positive thinking (Warrier *et al.,* 2010).

44) Moringa in climate-change-mitigation and global warming

M. oleifera can play a significant role in soil and water conservation and in mitigating climate change. It is well adapted to weather, soil and other environmental adversities (Daba, 2016). The growth of the plant even in dry conditions is considered to act as good sink for CO_2 absorption and utilization. According to a study, the rate of CO_2 absorption by Moringa is 50 times higher than that of general vegetation (Villfuerte and Villfuerte-Abonal, 2009).

Another important study on *Moringa* and global warming is from Muriel (2010). According to him, one person emits 320 kg of CO_2 per year and it takes 23 Japanese cedar trees 50 years to absorb this amount of CO_2 but it takes two *Moringa* trees only two years to absorb this amount. Furthermore, If a family emits 2300 kg of CO_2 per year, it takes 160 Japanese cedar trees 50 years to absorb this amount of CO_2. On the other hand, it takes 10 *Moringa* trees two years to absorb this amount of CO_2. Moringa is thus a useful tool to sequester more CO_2 and fight global warming. Planting Moringa will, hopefully, mitigate the impacts of climate change (Muriel, 2010).

45) Water purification

Seed powder with or without husk has coagulant, flocculant, water softening and disinfectant effects in surface water, shallow water and groundwater purification (Santos Bazanella *et al.,* 2008; Sanchez- Martin *et al.,* 2010; Pritchard *et al.,* 2009, 2010; Poumaye *et al.,* 2012; Teh and Wu, 2014; Velázquez – Zavala *et al.,* 2016; Muyibim and Evison, 1994; Pollard *et al*., 1995; Nda Bigengeser and Narasiah, 1998; Kalogo *et al.,* 2000; Anwar *et al.,* 2007, Sanchez-Martin *et al.,* 2010). Good coagulation activity of seeds on the basis of microbial and physico-chemical

studies weas also recently reported by Osarughe *et al.* (2020) in case of industrial and Kitchen effluents. Adding seed powder may remove 90-99% of the bacteria present in the water (Omotesho *et al.,* 2013). After adding powder to water, it is stirred for 10-15 minutes and left for an hour or until water becomes clear and impurities sink in the bottom. Water should be filtered and boiled before drinking (Sutherland *et al.,* 1989; Jahn *et al.,* 1986; Mahmood *et al.,* 2010). Higher is the turbidity of water and temperatures, higher is the coagulant efficacy in an alkaline medium (Sanchez- Martin *et al.,* 2010; Pritchard *et al.,* 2010). Two-step purification of *M. oleifera* had significantly better turbidity removal as compared to singly-step purification (Sanchez- Martin *et al.,* 2010). It is reported to remove Calcium, Magnesium, Iron, Strontium, Aluminium (Bichi, 2013), Cadmium (Abedini and Alpour, 2015), nitrates (Rezende *et al.,* 2016), *textile dyes* (Beltran-Heredia *et al*., 2012b) and detergents (Beltran-Heredia *et al.,* 2012 a).

Bark has been reported to remove Nickel, lead, Sodium, Potassium, Calcium, and Magnesium (Reddy *et al.,* 2010 b) and leaf has been used to remove lead (Reddy *et al.,* 2010 a). Moringa mixed with activated carbon has been used to remove Copper, Nickel, Zinc, Cadmium, Chromium, Lead, etc. (Kalavathy and Mirinda, 2010; Bhargave *et al.,* 2015).

Kalibbala *et al.* (2009) reported that *M. oleifera* can remove trihalomethane (THM) precursors and iron from drinking water successfully. Fluoride from water is removed by interaction between *M. oleifera* and negative charge of the fluoride ion through ion adsorption mechanism. Fig. 3 describes inreraction between negatively charged colloids or stable particles with cationic proteins of *M. oleifera* and resulting floc formation and sedimentation of colloids (see Saini *et al.,* 2016). Gassenschmidt *et al.* (1995) isolated a flocculating protein from *M. oleifera*. Moringa also provide protection against Arsenic. The review published by Idris *et al.* (2016) based on 81 references present comprehensive data on seeds of *M. oleifera* in environmental application and describes from various references that seeds of this species may remove Arsenic, Cadmium, Argentum, Coupper, Lead, Chromium, Zinc and Mangnese in substantial amounts. They can remove pollutant like sodium lauryl sulphate from aqueous solution, humic acid and dyes, colour from distillery spent wash, water hardness, suspended solids, turbidity from palm oil mill effluent waste etc. (Idris *et al.,* 2016).

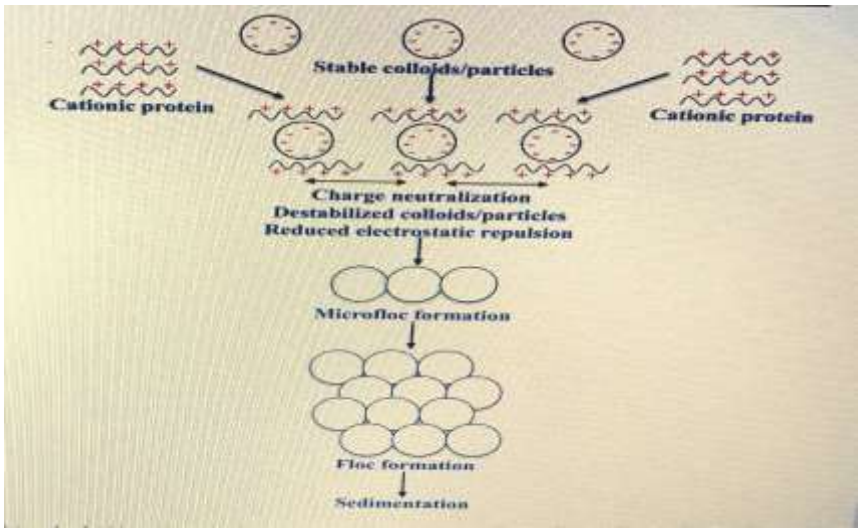

Fig. 3. Mechanism of Watercoagulation and sedimentation using *M. oleifera* cationic proteins. (Source: Saini *et al.,* 2016).

Sinha *et al.* (2016) compared ethanolic extracts of *M. oleifera* and *Azaditachta indica* for water purification potential of the two species. Ethanol extract of leaves of these species were found by them greatly efficient in the clarification and sedimentation of total solids of tannery wastewater sample. After 5-day incubation of water with the extract sample treated with extract reduction in water quality parameters (pH, EC, Cl, SO_4, hardness and TDS (Table 9). The dissolved oxygen (DO) increased by 83.33 % in *M. oleifera* and 133.33% under *A. indica* influence. EC and SO4 were almost equally reduced in the two treatments but chlorine was significantly more reduced with *A. indica*. The pH of water was slightly more acidic after treatment with *M. oleifera*. Summarizing the results of Sinha *et al*. (2016), the overall effects with two species were more or less similar but DO was better elevated with *A. indica*.

Table 9. Water parameters of untreated and *Moringa oleifera* and *Azadirachta indica* treated tannery wastewater (data from Sinha *et al.* (2016) after 5days of treatment. % Promotions or reductions over untreated control were calculated by us to compare the two plant species. Formula = Treated –Untreated / Untreated * 100.

Parameters	Untreated (control)	*Moringa* treated	% Promotion or Reduction	*Azadirachta indica* treated	% Promotion or Reduction
pH	7.30	4.85	-33.56	5.14	-29.59
DO	2.40	4.40	83.33	5.60	133.33
EC	2.34	0.897	-61.67	0.896	-61.71
Cl	65.32	62.48	-4.35	29.82	-54.34
SO_4	70.0	10.40	-85.14	11.60	-83.43
Hardness	2380	2040	-14.29	1760	-26.05
TDS	382.8	192.0	-49.84	184.2	-51.88

46) Moringa forage for feeding animals

Hanuk (2018) reviewed the use of *M. oleifera* leaves as forage for feeding animals, researched by various workers on cattle, buffalo, broilers, laying hens and rabbits by supplements to their diets. It improved growth of cattle and buffalo and rabbits, improved egg production in hens. The inclusion of seed meal at the rate of 7.5% was not found lethal to the experimental broiler chicks (Annongu *et al.*, 2014). The supplementation of *Moringa* may, play a role in the immunity building, sound health and poultry production performance (Mahfuz and Piao, 2019). No lethal dose was discovered for Moringa supplement in rats (Villarruel-López *et al.* (2018). No significant difference in genotoxic parameter of rats supplemented with *Moringa* was found. Nutrition value of leaves is described along with traditional medicinal use of the plant parts in detail by Agbogidi and Ilondu (2012).

High level of crude protein and the index of digestible protein in the intestine (PDI) make the *Moringa* leaf a protein supplements to animals for highly productive cattles (Makkar and Becker, 1996). In Nicaragua, good results have been obtained with *Moringa* leaves added with molasses and sugarcane straw (Radovich, 2011).

Nathaneil (2021) have assessed the effectiveness of *Moringa oleifera* and *M. stenopetala* leaves on growth, blood and gut microbiota in broiler chicken (Cobb500 broiler chicken from Kenchic Ltd. Kenya). The leaf powders from the two species were potent promoters in terms of weight gain. Similar results were obtained with ethanolic and aqueous extracts. There was no negative effect on haematological parameters. The chickens which received leaf powder of the two plant species had significantly low count of coliform. They suggested the leaf powders of *M. oleifera* and *M. stenopetala* as alternative and safer broiler chicken feed supplements. Further validation and authentication of the use of two species is, however, needful.

47) *Moringa Oleifera* active against *Anopheles gambiaes* and *Aedes aegyptii*

M. oleifera also inhibits growth of larvae of anopheles gambiaes (Chuang *et al.*, 2007; Prabhu *et al.*, 2011). Moringa activity against *Aedes aegyptii* (vector of dengue virus) owing to its contents of β - amyrin, β-Sitosterol, Kaempferol and Quercitin (Pontual *et al.* (2012).

48) Moringa in poverty alleviation

Ometesho *et al*. (2013) indicated potential of *M. oleifera* tree for poverty alleviation and rural development. It can be used to overcome malnutrition (Halder and Kosankar, 2017).

49) Heliobactor pylori

Moringa *oleifera* Lam. is rich in fibers and isothiocyanates which have anti-bacterial activity. It may help to rid off *H. pylori*, the bacteria causing gastritis and gastric cancer (Paikra *et al*., 2017).

50) Antiepileptic activity

Amrutia *et al*. (2011) reported that methanolic extract of *M. oleifera* leaves to exhibit potent anticonvulsant activity at the dose level of 200mg / kg and 400 mg/kg administered intraperitoneally when diazepam anf phenytoin were used as reference standard.

51) Oral hygiene

M. oleifera is used for oral hygiene (Jose *et al*, 2011). It is used to mineralize enamel and dentin in patients having erosive and wasting disease of teeth (Khalaf *et al., 2*016). It is antimicrobial and works against dental plaque (Yadav *et al.,* 2021).

52) Wound-closure and tissue regeneration

Improvement in tissue regeneration, decrease in wound size, and remarkable anti-proliferative and anti-migratory effects on normal human dermal fibroblasts have been reported (Cácares *et al.*, 1992; Lambole and Kumar, 2012). The antibacterial efficacy of aqueous and ethanol extracts of fresh and dried leaves of *Moringa oleifera* against

several pathogens isolated from wound and feaces, indicated potential their in the treatment of wound infection and typhoid fever (Dike-Nduddin *et al.,* 2016). Antipyretic and wound healing properties of ethanolic and ethyl acetate leaf extracts of *Moringa oleifera* have also been reported by Hukkeri *et al.* (2006).

53) Lead toxicity and Moringa

Lead is dangerous pollutant and shows nephrotoxic effects in humans. Curing effects of leaf extract of Moringa have been recorded on lead toxicity (Mohamed *et al.,* 2020) in rats. Further studies are, however, suggested to determine safety for prolonged use of its leaves.

54) Osteoporosis

The *Moringa* flavonoids increase bone density, which allows to prevent osteoporosis (Nijveldt *et al.,* 2001).

55) Urinary tract infections

Shaw and Jana (1982) reported efficacy of *M. oleifera* in lower urinary tract infections.

56) Toxicity due to Moringa

Steroids, alkaloids, tannins and saponions are considered poisonous compounds of Moringa. It is toxic at certain doses and overuse can cause genotoxicity (Liu *et al.,* 2021). Intake of root bark juice may cause acute skin inflammation and dermatitis (Alagesa Boopathi (2019). Hydroethanolic extract from Moringa cultivated in Selangor, Malaysia, was lethal to female ICR-mice if given in doses higher than 2000mg/kg. At this level the extract was reported to cause mild anaemia, stress leucogram and mild to moderate hepatonephrotoxicity (Aliyu *et al.,* 2021). They considered regular and repeated dose at 1000mg/kg to be unsafe. However, lower doses and /or administration for short time could be used safely for medicinal purpose. Adepapo *et al.* (2009) have reported that plant is relatively safe for nutritional and medicinal uses. Horas *et al.* (2021) have reviewed and characterized *M. oleifera* as a functional food and natural food additive. They, however, opined that many reports are inconclusive, and some data are even contradictory. It was probably the reason for its commercialization prohibition in Brazil in 2019 (Horas *et al.,* 2021). Earlier, Farooq *et al.* (2012) also suggested for its legitimate appraisal in modern medicine. Moreover, the content of Arsenic in San Pedro (Mexico) sample was reported to be higher than the permissible limit (Valdez-Solana *et al*. (2015).

57) Future risk to *Moringa oleifera*

The utility of *M. oleifera* is immense which may lead to its over-exploitation. Therefore, Gupta *et al.* (2018) have suggested the conservation of the tree and its afforestation on large scale. In planted populations of *M. oleifera* in Sanja, North Gondar, Ethiopia by farmers, Gedefaw (2015) have reported Moringa aboveground biomass varying with size between 9.788 and 197.485 ton per Ha and belowground biomass between 1.96 and 39.49 ton / ha. He also reported on carbon stocks in the aboveground biomass varying from 4.894 to 98.742 ton per ha in the plots studied.

Of course, there is need of raising awareness about the merits of Moringa to the people who should undertake plantation of this tree around houses and in the field. The farmers should come forward planting this plant which is fast-growing and beneficial in so many ways.

As discussed above in the paper, *M. oleifera* is an exceptionally important multipurpose tree. Its usefulness in therapeutics and other areas cannot be overemphasized but still regressive research is needed on various aspects. More comprehensive studies related to the phytochemicals should hopefully enhance pharmaceutical exploration in the field of cancer prevention (Al-temimi *et al.,* 2017). Moringa extracts provide unlimited opportunities for discoveries of new drugs owing to a variety of chemicals present in them (Sridharan *et al.,* 2011). Data from real clinical trials are, however, meagre and studies on extracts activity have generally been made *in vitro* (Lui *et al.,* 2021). Since there is still some lack of data on the pharmacology, toxicity, agricultural economy and dietary benefits of its constituents, its extracts require further evaluation. There are, however, many studies confirming to its usefulness in many ailments in human populations owing to its richness in antioxidants with rational roles as prophylactics and therapeutic actions. Although it has multifaceted pharmaceutical potential and some breakthough has been recorded in isolation, identification and structuraral elucidation of therapeutically bioactive principles, research is still needed to ascertain its safety in humans. Many products of Moringa in market need to be assessed for their quality and safety ((Papoola *et al*., 2020).

REFERENCES

Abalaka, M.E., S.Y. Daniyan, S.B. Oyeleke and S.O. Adeyamo (2011). The antibacterial evaluation of *Moringa oleifera* leaf extracts in selected bacterial pathogens. *J. Microbial. Research*, 1(1): 1-4.

Abd Rani, N. Z., K. Hussain and E. Kumolosasi (2018). *Moringa* genus: A review of phytochemistry and pharmacology. Front Pharmacology. Vol. 9. Article 108: Pages 1-26. (Doi: 10.2289/fphar.2018.00108).

Abd Rani, N.Z., E. Kumolosasi, M. Jasamai, J.A. Jamal, K.W. Lam and K. Hussain (2019). In vitro anti-allergic activity of *Moringa oleifera* Lam. extracts and their isolated compounds. *BMC Complementary and Alternate Medicine*. 19. Article # 361. (http://doi.org/10.1186/s12906-019-2776-1)

Abdulkarim, S., K. Long, O. Lai, S. Muhammad, and H. Ghazali (2005). Some physico-chemical properties of *Moringa oleifera* seed oil extract using solvent and aqueous enzymatic methods. *Food. Chem.* 93: 253-263.

Abdulkarim, S.M., K. Long, O.M. Lai, S.K.S. Mohammad and H.M. Ghazali (2007). Frying quality and stability of high-oleic *Moringa oleifera* seed oil in comparison with other vegetable oils. *Food Chem.* 105: 1382-1389.

Abedini, S. and V. Alpour (2015). Cadmium removal from synthetic wastewater by using *Moringa oleifera* seed powder. *Environmental Health Engineering Management Journal* 2(4): 157-163. (Seen in Velázquez-Zavala *et al.,* 2016).

Adenike, A.B. (2014). The effects of drying on some nutrients of *Moringa oleifera* leaves. *Ann. Food Sci. and Tech*. 15(2): 249-250.

Adepapo, A.A., O.M. Mogbojuri and B.O. Emlkpe (2009). Safety regulations of the aqueous extract of the leaves of *Moringa oleifera* in rats. *J. Med. Plants Res*. 3(8): 586-591.

Agarwal, B. and A. Mehta (2008). Antiasthmatic activity of *Moringa oleifera* Lam. A clinical study. *Indian J. Pharmacol*. 40(1): 28-31.

Agbogidi, O.M. and E.M. Ilondu (2012). *Moringa oleifera* Lam.: Its potential as a food security and rural medicinal item. *J. Bio. Innov.* 16: 156-167.

Alagesa Boopathi, C. (2019*). Medicinal and Poisonous Plants of India.* MJP Publisher. Pp. 215.

Al-Asmari, A.K., S.M. Albalawi, Md. T. Athar, A.Q. Khan, H. Al-Shahrani and M. Islam (2015). *Moringa oleifera* as an anticancer agent against breast and colorectal cancer cell lines. *PloS One* 10(8): e0135814. (http://doi.org/10.137/journal.pone.0135814).

Albasher, G., R. Alrajhi, E. Alshammry and R. Almeer (2021). *Moringa oleifera* leaf extract attenuates Pb-acetate-induced testicular damage in rats. *Combinational Chemistry and High Throughput Screening.* 24(10): 1593-1602. (Doi: 10.2174/1386207323666200923142283).

Alegbeleye, O.O. 92018). How functional is *Moringa oleifera*? A review of its nutritive, medicinal and socioeconomic potential. *Food and Nutrition Bulletin* 39(1): 149-170.

Aleksic, A. (2020). Top 22 *Moringa* health benefits + side effects. http://selfhacked.com.

Aliyu, A., M.R. Shaari, N.S.A. Sayti, F.H. Reduan, S. Sithambaram, N.M. Mustafa, K. Shaari and H.B. Hamzah (2021). *Moringa oleifera* hydroethanolic leaf extract induced acute and sub-acute hepato-nephrotoxicity in female ICR -mice. *Science Progress* 104 (4):1-36. (doi:10.1177/00.368504211004272)).

Al-Malki, A, L. and H.A. El Rabey, (2015). The antidiabetic effect of low doses of *Moringa oleifera* Lam. seeds on streptozotocin induced diabetes and diabetic nephropathy in male rats. *Biomed. Res. Int*. 2015 (2015) 1–13.

Almeida, A.P. da Silva, Ivete Aparecida Pandoff Oller,, Adrian M. Ragassi Fiorini, Elen Landgraf Guiger, Adriana Cressoni Araújo, M. Oshiiwa, A.M.B. Ottobani, E. A.de Oliviera, L. C.C.T, Nicolau, V. M. Imaizumi, R.G. Eleutério, J. Novae Matias and S.M. Barbalho (2021). An overview of the effects of *Moringa oleifera* on health. *Int. J. Development Research* 11(2): 44781-44784.

Alqahtani, W.S. and G. Albasher (2021). *Moringa oleifera* Lam. extract rescues lead-induced oxidative stress, inflammation and apoptosis in the rat cerebral cortex. *J. Food Biochem* 45 (1): e13579. (doi:10.1111/jfbc.13579).

Al-Sharif, I., A. Remmal, A. Aboussekhra (2013). Eugenol triggers apoptosis in breast cancer cells through E2F1/surviving down-regulation. *BMC Cancer* 13(1):600. (Pages 1-10). (Doi: 10.1186/1471-2407-13-600).

Al-tamimi, A., N. Lakhassassi, A. Baharlouki, D. G. Watson and D.A. Lightfoot (2017). Phytochemicals: extraction, isolation and identification of bioactive compounds from plant extracts. *Plants* 6(42): (Doi. 10.3390/plants6040042).

Amaglo N.K., R.N. Bennett, R.B. Lo Curto, E. A. S. Rosa, V. Lo Turco, A. Giuffrida, A. Lo Curto, F. Crea, G.M. Timpo (2010) Profiling selected phytochemicals and nutrients in different tissues of the multipurpose tree *Moringa oleifera* L., grown in Ghana. *Food Chemistry* 122:1047–1054.

Amara, I., M.L. Ontario, M. Scuto, G.M.L. Dico, S. Scinto, V. Greco, S. Abid-Essefi, A. Signorile, A.T. Salinaro and V. Calabres (2021). *Moringa oleifera* protects SH-SY5 Ycells from DEHP-induced endoplasmic reticulum stress and apoptosis. *Antioxidants* (Basel) 10(4): 532. (Doi: 10.3390/antiox10040532).

Amrutia, J., L.M. Srinivasan and R.S. Moses (2011). Anticonvulsant a tivity of *Moringa oleifera* leaf. *Int. Res. J. of Pharmacy* 2(7): 160-162.

Annougu. A., O.R. Karim, A.A. Toye, F.E. Sola-Ojo and K.D. Adeyami (2014). Geo-assessment of chemical composition and nutritional evaluation of *Moringa oleifera* seeds in nutrition of broilers. *J. Agricultural Sci*. 6(4): 119-124.

Anonymous (2003). *Monographs of Unani medicine.* Vol. 1. Bait ul Hikmah, Hamdard Foundation Pakistan. Drug Control and Traditional Medicine Division, NIH, Islamabad, pp. 1-664.

Anwar, F. and U. Rashid (2007). Physico-chemical characteristics of *Moringa oleifera* seeds and seed oil from a wild provenance of Pakistan. *Pak. J. Bot.*39 (5): 1443-1453.

Anwar, F., S. Latif, M. Ashraf and A.H. Gilani (2007). *Moringa oleifera*: a food plant with multiple biochemical and medicinal uses - a review. *Phytother. Res.*21:17-25.

Anwar, F.; Ashraf, M. and M.I. Bhanger (2005). Interprovenance variation in the composition of *Moringa oleifera* oilseeds from Pakistan. *J. Am. Oil Chemists Soc*. 82:45.

Aronson, D. and E.J. Rayfield. (2002). How hyperglycemia promotes atherosclerosis: molecular mechanisms, Cardiovasc. *Diabetol.* 1 (2002): 1.

Atawodi, S.E., J.C. Atawodi. G. Wurtele, H. Bartsch, R.W. Owen, G.A. Idakwo, B. pfundstein and R. Haubner (2010). Evaluation of polyphenol content and antioxidant properties of methanol extracts of the leaves, stem and root bark of *Moringa oleifera* Lam. *Med. Food* 13 (3): 710-716.

Ayirezang, F. A., B. K. Azumah, and S. Achio (2020). Effects of *Moringa oleifera* leaves and seeds extracts against food spoilage fungi. *Advances in Microbiology* 10(1): 27-38. (http:// doi.org/10.4236/aim.2020.1010031).

Azad, A.K., M.G. Rasul, M.M.K. Khan, C. Subhash, C. Sharma and R. Islam (2015) Prospect of Moringa seed oil as a sustainable biodiesel fuel in Australia: a review. *Procedia Eng.* 105:601–606. (doi: 10.1016/j.proeng.2015.05.037).

Azam, M.M., A. Waris, and N.M. Nahar (2005). Prospects and potential of fatty acid methyl esters of some non-traditional seed oils for use as biodiesel in India. *Biomass Bioenergy* 29:293–302.

Baeza-Jiménez, R., R. Flores-Flores, M.A. Movales-Ovando and L. X. Lopez-Martínez (2022). Phytochemicals and Health benefits (Chapter 4). PP. 66-75). In: Basillo Heradia and E.P. Gutiervez-Grijalvo (2022). *Biological and Pharmacological Properties of the genus Moringa.* CRC Press (Yaylor and Francis Group). 2, Park Square, Milton Park, Abingdon, Oxon, OX144RN. pp. 212.

Bais, S., G.S. Singh and R. Sharma (2014). Antiobesity and hypolipidemic activity of *Moringa oleifera* leaves against high fat dieyt-induced obesioty in rats. *Advances in Biology*, vol. 2014. Article ID-162914.

Bamishaiye, E.I., F.F. Olayemi, F.F. Awagu and O.M. Bamishaiye (2011). Proximate and phytochemical composition of *Moringa Oleifera* leaves at three stages of maturation. *Adv. J. of Food Sci. & Tech*. 3(4): 233-237.

Bandana, M., H.N. Khanikor, L.C. Lahon, P. Mohan and C. Bania (2003). Analgesic, anti-inflammatory and local anaesthetic activity of *Moringa* in laboratory animals. *Pharmaceutical Biology* 41(4); 248-252.

Barkat, H. and G.A. Ghazal (2016). Phytochemical properties of Moringa oleifera seedsand their oil cultivated at different regions of Egypt. Food and Nutrition Sciences7:472-484. (http://dx.doi.org/10.4236/fns.2016.76049)

Basillo Heradia and E.P. Gutiervez- Grijalvo (2022). *Biological and Pharmacological Properties of the genus Moringa*. CRC Press (Yaylor and Francis Group). 2, Park Square, Milton Park, Abingdon, Oxon, OX144RN. pp. 212.

Bekoe, E.O. (2020). Physico-chemical, phytochemical, heavy metal and microbiological analysis of *Moringa oleifera* Lam. *Pharmacogn J.* 12(6) Supplementary: 1561- 1566.

Beltran-Heredia, J., J. Sánchez-Martin, A. Muñoz-Serrano and J.A. Peres (2012 a). Long-chain anionic surfactants in aqueous solution. Removal by *Moringa oleifera* coagulant. *Chem. Engg. Journal.* 180 (15): 128-136.

Beltran-Heredia, J., J. Sánchez-Martin, A. Muñoz-Serrano and J.A. Peres (2012 b). Towards overcoming TOC increase in wastewater treated with *Moringa oleifera* seed extract. *Chemical Engg. Journal.* 188: 40—46.

Ben Salema, H. and H.P.S. Makkar (2009). Defatted *Moringa oleifera* seed meal as a feed additive for sheep. *Animal Feed Science and Technology.* 150:27.

Bennet, R.N., F.A. Mellon, N. Foidl, J.H. Pratt, M.S. Dupont, L. Perkins and P.A. Kroon (2003). Profiling of lucosinolates and phenolics in vegetative and reproductive tissues of the multipurpose tree *Moringa oleifera* (horseradish) and *Moringa stenoptala* L. *J. Agric. Food Chem.* 51 (12): 3546-3553.

Bhalla, N., N. Ingle, S. V. Patri and D. Haranath (2021). Phytochemical analysis of *Moringa oleifera* leaves extracts by GC-MS and free radical scavenging potency for industrial applications. *Saudi J. Biol. Sci.* 28: 6915-6928.

Bharali, R, J. Tabassum, M.R.H. Azad. (2003). Chemomodulatory effect of *Moringa oleifera*, Lam, on hepatic carcinogen metabolizing enzymes, anti-oxidant parameters and skin papillomagenesis in mice. *Asia Pacific J. Cancer Prevention*. 4: 131–139.

Bhargave, A., J. Pandey, K. Singh, Nama and M. Pandey (2015). *Moringa oleifera* Lam.- Sanjana (Horseradish tree) – A miracle food plant with multipurpose uses in Rajasthan, India – An overview. *Int. J. Pure Appl. Bioscience.* 3(6): 239-248.

Bichi, M.H. (2013). A review of the applications of *Moringa oleifera* seed extracts in water treatment. *Civil and Environmental Researc*h 3(8): 1-11. (Seen in Velázquez-Zavala *et al.*, 2016).

Bichi, M.H., J.C. Agunwamba, S.A. Muyibi and M.I. Abdul Karim (1995). Effect of extraction method on the antimicrobial activity of *Moringa oleifera* seeds extract. *J. Am Sci.* 8: 450-458.

Biswas, S.K., A. Chowdhury, J. Das, A. Roy and S.M.Z. Hosen (2012). Pharmacological potentials of *Moringa oleifera* Lam,: A Review. *Int. J. Pharmaceutical Sciences and Research* 3(2): 305-310.

Borneo, R., E.A. Leon, A. Aguirre, P. Ribotta and J.J. Cantero (2008). Antioxidant capacity of medicinal plants from the Province of Cordoba (Argentina) and there *in vitro* testing in model food system. *Food Chem.* 12: 664-670.

Brilhante,,R.S.N., J.A. Sales, V.S. Pereira, Débora de C.M. Castelo-Branco, R. de A. Cordeiro, C. M. de Souza Sampaio, M. de A.N. Paiva and J.B.F. dos Santos, J.J. C. Sidrim and M. Fábio Gadelva Rocha (2017). Research advances on the multiple uses of *Moringa oleifera*: A sustainable alternative for socially neglected population. *Asian pacific J. Tropical Medicine* 10(7): 621-630.

Broderick, M.T., A.D.P. Prince, A. Dhukawa, D. Mukherjea, P. Jiang, K. C.M. Campbell, L.P. Rybrack and M.J. Brenner (2021). Effects of Moringa extract on aminoglycoside-induced hair cell death and organ of corti damage. *Otol. Neurotol*. 42 (8): 1261-1268. (doi:10.1097/Mao.0000000000003193)

Cácares, A., A. Saravia, S. Rizzo, I. Zabala, E.D. Leon and F. Nave (1992). Pharmacologic properties of *Moringa oleifera. 2*: preliminary screening for antispasmodic, anti-inflammatory and diuretic activity. *J. Ethnopharmacology* 36 (3): 233-237.

Cáceres, A. and S. Lopez (1991). Pharmacologic properties of *Moringa oleifera*: 3: Effect of seed extracts in the treatment of experimental pyoderma. *Filoterapia* 62: 449-450.

Cáceres, A.B., O. Cabrera, O. Mirals, O. Molliendo and A. Imendia (1991). Preliminary screening for antimicrobial activity of *Moringa oleifera*. *J. Ethnopharmacology*. 33: 213-246.

Cajuday, L.A. and Pocsidio (2010). Effects of *Moringa oleifera* Lam. (Moringaceae) on the reproduction in male mice (Musmusculus). *J. Med. Plant Res. 4*: 1115-1121.

Calabrese, V., E. Cornelius, M. Sapienza, M. Penebiano S. Calafato, E. Puleo, G. Pennisi, C. Mancuso, D.A. Butterfield and A.G. Stella (2007). Redox regulation of cellular stress response in ageing and neurodegeration disorders: Role of vitagenes. *Neurochem. Res*. 32: 757-783.

Cerf, M.E. (2015). Beta cell dysfunction and insulin resistance. *Front. Endocrinol.* 4 (2013) 1–12.

Charoensin, S. (2014). Antioxidant and anticancer activities of *Moringa oleifera* leaves. *J. Medicinal Plant Research*. 8 (7): 318-325

Choder, G.M., M.E. Olson, K.L. Wader, K.K. Stephanson, W. Nouman, Grima and J.W. Fahey (2018). Wild and domesticated *Moringa oleifera* differ in taste, glucosinolates composition and antioxidant potential but not myrosinase activity or protein content. *Sci. Reports* 8:7995. (Doi: 10.1038/s41598-018-26059-3).

Christiano, V. and F. Smarandache (2019). On the efficacy of *Moringa oleifera* as anticancer treatment: A literature survey. *BAOJ Cancer Research & Therapy* 5(2): 069.

Chuang, P.H., C.W Lee, J.Y. Chou, M. Murugan, B.J. Sheikh and H.M. Chen (2007). Anti-fungal activity of crude extracts and essential oil of *Moringa oleifera* Lam. *Bioresource Technology* 98: 232-236. (Doi: 10.1016/j.biotech).

Chumark, P., P. Khumawat, Y. Sanavarinda, S. Phorncherasilp, N.P., Morales, L. Phivthong-ngam, P. Ratanachanong, S. Srisawat and K.S. Pongrapeeporn (2008). The in vitro and ex vivo antioxidants properties, hypolipidaemic and antiantherosclerotic activities of water extract of *Moringa oleifera* Lam. leaves. *J. Ethnopharmacology* 116(3): 439-446.

Coppin, J. (2008). *A Study of the Nutritional and Medicinal Values of Moringa oleifera Leaves from sub-Saharan Africa: Ghana, Rwanda, Senegal and Zambia.* M.Sc. thesis, Rutgers University-Graduate School-New Brunswick, New Brunswick.

Da Silva, A.R. and W.E. Kerr (1999). Moringa: Uma nova hortaliça para o Brasil. Uberlãndia M.G. Brazil: UFU/ Diriu [p.95]. (Seen in Teixeira *et al.* (2018).

Daba, M. (2016). Miracle tree: A review on multipurposes of *Moringa oleifera* and its implications for climate change mitigation. *J. Earth Sci. Clim. Change* 7 (8): 366. (Doi:10.4172/2157.7617-1000366).

Dahiru, D., I. Onubiyi and H. A. Omaru (2006). Phytochemical screening and anti-ulcerogenic effect of *Moringa oleifera* aqueous leaf extract. *Afr. J. Traditional, Complementary and Alternative Medicines* 3(3): 70-75.

Dahot, M.U. (1988). Vitamin contents of flowers and seeds of *Moringa oleifera*. *Pak. J. Biochem. Mol. Biol.* 21: 1-24.

Das, B.R., P.A. Kurup and P.L. Narasimaha Rao (1957). Antibiotic principle from *Moringa pterysperma*. Part VII. Structure of 6 compounds related to pterygo spermin. *Ind. J. Med. Res.* 45: 191-196.

Delaveau, P. and P. Baiteau (1980). Oils of *Moringa oleifera* and *Moringa drouhardii*. *Plantes Medicinalis et Phytotherapic* 14: 29-33.

Denton, O.A. and G.J.H. Grubben (2004). Plant resources of tropical Africa. 2. Vegetable. PROTA Foundation / Backnuy Publishers / CTA Wageningen, Netherlands Research.

Dhakar, R., S. Maurya, B. Pooniya, N. Bainwa, M. Gupta and Sanwarmal (2011). *Moringa*: The herbal gold to combat nutrition. *Chronicles of Young Scientists* 2(3): Madknow Publ. & Media Pvt., Ltd.

Dike-Nduddin, J.N., G.O. Ariyanwn, R.C. Egbuoli, H.M. Okorie, H.I. Udujih, D.C. Nwosu, and N.J.C. Okolie (2016). Antibacterial and phytochemical potential of *Moringa oleifera* leaf extracts on some wound and enteric pathogenic bacteria. *European J. Botany, Plant Sciences and Phytology* 3(1): 50-60.

Dodiya, B. and B. Amin (2015). Antibacterial activity and phytochemical screening of different parts *of Moringa oleifera* against selected gram positive and negative bacteria. *J. Pharmaceutical, Chemical and Biological Sciences* 3(3): 421-425.

Drue, G.E.H.S. and R. C. Minor (2018) Moringa oleifera tea alters neutrophil but not lymphocyte levels in blood of acutely stressed mice. Madridge J Immunol 2:43–48.

Duthie, S.J.; A. Ma, M. A. Ross, and A. R. Collins, (1996). Antioxidant supplementation decreases oxidative DNA damage in human lymphocytes. *Cancer Res.* 56, 1291–1295.

Eilert, U., B. Walters and A. Nahrstedt (1981). The antibiotic principle of seeds of *Moringa oleifera* and *M. stenoptela*. *Planta Med.* 42: 55-61.

El-Nagdi, W.M.A. and M.M.A., Youssef (2015). Nematicidal Effect of Some Aqueous extracts of botanicals and a commercial bacterial byproduct for biocontrolling root-knot nematode, *Meloidogyne incognata* infecting sugar beet. *Scientia Agriculture* 10(2); 55-58.

El-Shohaimy, S.A., G.M. Hamad, S.F. Mohamed, M.H. Ather and R.R. Al-Hindi (2015). Biochemical and functional properties of *Moringa oleifera* leaves and their potential as a functional food. *Global Adv. Res. J. Agric. Sci.* 4: 188-199.

Ezeamuzle, I.C., A.W Ambadederomo, F.O. Shode, and S. C. Ekwebelem (1996). Anti-inflammatory effects of *Moringa oleifera* root extract. *Int. J. Pharmacognosy*. 34:207.

Ezeigbo, O.R., C.S. Barrah and I.C. Ezeigbo (2016). Phytochemical analysis and antidiabetic effect of aqueous and ethanolic extracts of *Moringa oleifera* leaves in alloxan-induced diabetic Wistar albino rats using insulin as reference drug. *Int. J. Diabetes Res*. 5(3): 48-53.

Fahal, E.M., A.M. Babitha Rani, M.D. Aklakur, T.J. Chany and N. Saharan (2018). Qualitative and quantitative phytochemical analysis of *Moringa oleifera* (Lam.) pods. *Int. J. Curr. Microbiol. Appl. Sci.* 7(5): 657-665.

Fahey, J. (2005). *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part I. *Trees for Life Journal (www. TFL.journal.org)*. (http//www.TFL.journal.org/article. Php/20051201124931586).

Faizi, S., B. S, Siddiqui, R. Saleem, K. Aftab, F. Shaheen and A. H. Gillani. (1998). Hypotensive constituents from pods of *Moringa oleifera*. *Planta Medica. 3:957.*

Faizi, S., B. S. Siddiqui, R. Saleem, F. Noor and S. Hussain (1997). Isolation and structure elucidation of a novel glycoside Niazidin from the pods of *Moringa oleifera*. *J. Natural Products* 60(12): 1317-1321.

Faizi, S., B. S. Siddiqui, R. Saleem, S. Siddiqui, K. Aftab, A.H. Gillani *et al.* (1995). Fully acylated carbamate and hypotensive thiocarbamate glycosides from *Moringa oleifera*. *Phytochem.* 38: 957-963.

Faizi, S., B.S. Siddiqui, R. Saleem, Salimuzzaman Siddiqui and K. Aftab (1994). Isolation and structure elucidation of new nitrile and mustard oil glycosides from *Moringa oleifera* and their effect on blood pressure. *J. Natural Products* 57(9): 1256-1261.

Fakurazi S, S.A. Sharifudin and P. Arulselvan (2012) *Moringa oleifera* hydroethanolic extracts effectively alleviate acetaminophen induced hepatotoxicity in experimental rats through their antioxidant nature. *Molecules* 17:8334–8350

Farooq, A. and U. Rashid (2007). Physico-chemical characteristics of *Moringa Oleifera* seeds and seed oil from a wild provenance of Pakistan. *Pak. J. Bot.* 39(5): 1443-1453.

Farooq, F., M. Rai, A. Tiwari, A. R. Khan, and Shaila Farooq (2012). Medicinal properties of *Moringa oleifera*: An overview of promising healer. *J.Med. Plants Res.* 6(27): 4368-4374.

Farrokhzadeh, H. E. Taheri, A. Ebrahimi, A. Fatehzadeh, M.V. Dasjerdi and B. Bina (2013). Effectiveness of *Moringa oleifera* powder in removal of heavy metals from aqueous solutions. *Fres. Environ. Bull.* 22: 1516-1523.

Ferreira, P.M.P., D.F. Farias, J.T. Oliveira, de A, A. Carvalho and F.U. de (2008). *Moring oleifera*: Bioactive compounds and nutritional potential. *Revista de Nutriçao* 21(4): 431-437.

Fidrianny, I., I.Kanapa and M. Singgih (2021). Phytochemistry and pharmacology of Moringa tree: An overview. *Biointerface Res. In Applied Chem.* 11(3):10776-10789.

Flora, S.J.S. and V. Pachauri (2011). Moringa (*Moringa oleifera*) seed extract and the prevention of oxidative stress. In: *Nuts and seeds in health and disease prevention*. Elsevier Inc. Amsterdam, the Netherlands. p. 776.

Foidl, N., H.P.S. Makkar and K. Becker (2001). The potential of *Moringa oleifera* for agricultural and industrial uses. In: *The miracle tree: The multiple attributes of Moringa*. (Ed. J. Lowell Fuglie). CTA Publication. Wageningen, the Netherlands. p. 45-76.

Franco, G. (2005). *Tabela de composição Quimica dos ailmentos* (9th Ed.). São Paulo Brazil. Atheneu. P. 307.

Fuglie, L.J. (1999). Miracle tree, *Moringa oleifera*, natural nutrition for the tropics. Dakar: Church World Service. P 68.

Fuglie, L.J. (2001). Combating malnutrition with Moringa. In: *The miracle tree: the multiple attributes of Moringa.* (Ed. L.J. Fuglie). CTA Publication. Wageningen, the Netherlands. p. 117.

Ganatra-Tejas, H., U.H. Joshi, P.N. Bhalodia, T.R. Desai and Tirgar (2012). A panoramic view on pharmacognostical, nutritional, therapeutic and prophylactic values of *Moringa oleifera* Lam. *Int. Res. J. Pharmacy* 3 (6): 1-17.

Ganguly, R. and D. Guha (2008). Alteration of brain monoamines and EEG wave pattern in the rat mode; of Alzheimer's disease and protection by *Moringa oleifera*. *Indian J. Med. Res.* 10: 744-751.

Garga, M.A., S.B. Manga, A.B. Rabah, H. Tahir, M. Abdullahi, M. Ahmad, H.A. Abdullahi, I. Bako, S.A. Abdurrahman and U.F. Mukhtar (2019). Antibacterial activity and phytochemical screening of *Moringa oleifera* Lam. leaves and seed extract on *Staphylococcus aureus*. *Int. J. of Research- granthaalayah: A Knowledge Repository* 7 (11): 276-284.

Gassenschmidt, U. K.D. Jany, B. Tauscher and H. Niebergall (1995). Isolation and characterization of a flocculating protein from *Moringa oleifera* Lam. *Biochimica Biophysica Acta.* 1243: 477-481.

Gedefaw, M. (2015). Environmental and medicinal value analysis of Moringa (*Moringa oleifera*) tree species in Sanja, North Gondar, Ethiopia. AIJCSR-480 (June – July): 2 (4): 20-35.

Ghasi, S., E. Nwabodo and J.O. Ofili (2000). Hypocholesterolaemic effect of crude leaf extract of *Moringa oleifera* in high fat diet fed Wistar rats. *J. Ethnopharmacology* 69(1): 21-25. (Doi: 10.1016/s0378-8741(99)00106-3).

Ghazali, H.M. and A.S. Mohammed (2011). Moringa (*Moringa oleifera*) seed oil: composition, nutritional aspects, and health attributes. In: *Nuts and Seeds in Health and Disease Prevention.* (Eds. V.R. Preedy, R. Ross and V.B. Patel). Elsevier Inc. Amsterdam, the Netherlands. p. 787.

Gillani, A.H., K. Aftab, A. Suria, S. Siddiqui, R. Saleem, B.S. Siddiqui, S. Faizi (1994). Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from *Moringa oleifera*. *Phytotherapy Res.* 8(2): 87-91.

González-Romero, J., S. Arranz-Arranz, V. Verardo, B. Garcia –Vinanova, and E.J. Guerra – Hernández (2020). Bioactive compounds and antioxidant capacity of Moringa leaves grown in Spain versus 28 leaves commonly in pre-packaged salads. Processes 8, 1297. (Doi: 10.3390/pr8101297). www.mdpi.com/journal/processes

Gopalakrishnan, L., K. Doriya and D.S. Kumar (2016). *Moringa oleifera*: A review on nutritive importance and its medicinal application. *Food Sci. Human Wellness* 5: 49-56.

Guevara, A.P., C. Vargas and M. Uy (1996). Anti-inflammatory and antitumor activities of seed extracts of malunggay, *M. oleifera* L. (Moringaceae). *Philippine J. Sci.* 125:175.

Guevara, A.P., C. Vergas and H. Sakurai, Y. Fujiwara, K. Hashimoto, T. Maoka, M. Kozuka, Y. Ito and H. Tokudo (1999). An antitumour promoter from *Moringa oleifera* Lam. *Mutat. Res.* 440: 181-188. (Doi:10.1016/s1383-5718(99)00025-X).

Gupta, S., R. Jain, S. Kachhwaha and S.L. Kothan (2018). Nutritional and medicinal applications of *Moringa oleifera* Lam. – Review of current status and future possibilities. *J. Herbal Medicine* 11: 1-11.

Halder, R. and S. Kosankar (2017). *Moringa oleifera*: The Miracle tree. *Int. J. Adv. Res., Ideas and Innovations in Technology* 3(6): 966-970.

Hanuk, Y.L. (2018). Many uses of *Moringa oleifera* in human and animal nutrition. *Res. & Revs. J. Agric. And Allied sciences* 7(1): 41-45.

Harimalala Andriambelo Nirina, R. Miora, P. Vincent, A. Heol, F. Remizea and R. Louisette (2017). Phytochemical composition and antioxidant activity of fermented *Moringa oleifera* leaf powder. *Eur. J. Nutrition & Food Safety* 7(1): 78-84. (Doi:10.9734/EJNFS/2017/296277). Hal-01690372.

Horad, F. M. Rosa, T. Zorzenon and P.G. Milani (2021). *Moringa oleifera* potential as a functional food and a natural food additive: A biological approach. *An Acad. Bras. Cienc* 93 (Suppl. 4): e20210571. Doi: 10.1590/0001-3765202120210571).

Hukkeri VI, Nagathan CV, Karadi RV and Patil BS. (2006) Antipyretic and wound healing activities *of Moringa oleifera* Lam. in rats. *Indian J. Pharm. Sci.* 68:124-126.

Hussain, S., F, Malik and S. Mahmood (2014). Review: An exposition of medical preponderance of *Moringa oleifera* (Lamk.). *Pak. J. Pharm. Sci.* 27(2): 397-403.

Idris, A. and U. Abubakar (2016). Phytochemical and antibacterial investigations of Moringa (*Moringa oleifera*) leaf extract on selected bacterial pathogens. *J. Microbiology and antimicrobials* 8(5): 28-33.

Idris, M.A., M.S. Jami, A.M. Hammed, P. Jamal (2016). *Moringa oleifera* seed extract: A review on its environmental applications. *Int. J. Appl. Environmental Sci.* 11(6): 1469-1486. .

Idris, S. B. and U,R Adamu (2018). Phytochemicals and uses of *Moringa oleifera* leaves in humans and animals in Sokoto. *Journal of Animal Science and Veterinary Medicine*, 3, 30-34.

Igado, O.O. and J.O Olapade (2016). A review on the possible neuroprotective effects of *Moringa oleifera* leaf extract. *Niger. J. Physiol. Sci*. 31: 183-187.

Ijarotimi, O.S., O.A., Adeoti and O. Ariyo (2013). Comparative study on nutrient composition, phytochemical and functional characteristics of raw, germinated and fermented *Moringa oleifera* seed flour. *Food Sci. and Nutrition* 1 (6): 452-463.

Iqbal, S. and M.T. Bhanger (2006). Effect of season and production location on antioxidant activity of *Moringa oleifera* leaves growth in Pakistan. *J. Food Composition and Analysis* 19: 544-551.

Isitua, C. C., M.J. Sanches-Munro Lozano, C.J. Jaramillo and F. Duton (2015). Phytochemical and nutritional properties of dried leaf powder of *Moringa oleifera* Lam. from Machala el Oro Province of Ecuador. *Asian J. pl. Sci. & Res.* 5 (2): 8-16.

Islam, Z., S.M. Rashidul Islam, F. Hossen, K. Mahtab-ul-Islam, Md. Rakibul Hasan and Rezaul Karim (2021). *Moringa oleifera* is a prominent source of nutrients with potential health benefits. *Int. J. Food Sci.* (Hindawi). Article ID 6627265 (11 pages). (http:// doi.org/10.1155/2021/6627265).

Issa, S.B., M. Muazu and I. Rabi'u (2021). Phytochemical analysis and antibacterial activity of *Moringa oleifera leaves* extracts against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. *Asian J. Biochem, Genetics & Molecular Biology* 7(1): 34-53. (Doi: 10.9734/ajbgmb/2021/v7i130166).

Iwara, , I.A., G.A. Iglio, I.P. Ogar, O.E. Mboso, U.P Ubong. E.U. Eyong and E.P Ebong (2014). Antilipidemic effect of combined leaf estracts of *Moringa oleifera* and *Peristrophe bicalyculata* in alloxan-induced diabetic rats. *Pharmacology & Pharmacy* 51(4); 340-348. (Doi:10.4236/pp.2014-54041).

Jahn, S.A., H.A. Masnad and H. Burgstaller (1986). Tree that purifies water. Cultivating multipurpose Moringaceae in Sudan. *Unasylva* 38(152): 23-28.

James, A. and V. Zikankuba (2017). *Moringa oleifera*, a potential tree for nutrition security in sub–Saharan Africa. *Am. J. Res. Comm.* 5(4):1-14.

Jose, M., B.B. Sharma, M. Shantanum and S.A. Ahmed (2011). Ethnomedicinal herbs used in oral health and hygiene in coastal Dakshina Kannada. *J. Oral Health and Community Dentistry 5(3): 119-123.*

Jung, I.L. (2014). Soluble extract from *Moringa oleifera* leaves with new anticancer activity. *Plos One* 9, e95492.

Kalavathy, M.H. and L.R. Mirinda (2009). *Moringa oleifera* – A solid phase extractant for removal of copper, nickel and Zinc from aqueous solutions *Chem. Engg. J.* 158: 188-199.

Kalibbala, H., O. Walberg and T.J. Hawumbo (2009). The impact of *Moring oleifera* as a coagulant aid on the removal

Kalogo, Y., F. Rosilon, F. Hammes and W. Verstraete (2000). Effect of water extract of *Moringa oleifera* seeds on the hydrolytic microbial species diversity of a UASB reactor treating water waste. *Letters in Appl. Microbiol* 31: 259-264.

Kamalakkannan, N. and P.S.M. Prince (2006). Antihyperglycaemic and antioxidant effect of rutin, a polyphenolic flavonoid, in streptozotocin-induced diabetic wistar rats. *Basic Clin. Pharmacol. Toxicol.* 98 (2006) 97–103.

Kaneto, H., Y. Kajimoto, J. Miyagawa, T. Matsuoka, Y. Fujitani, Y. Umayahara, T. Hanafusa, Y. Matsuzawa, Y. Yamasaki and M. Hori (1999). Beneficial effects of antioxidants in diabetes: possible protection of pancreatic β-cells against glucose toxicity, *Diabetes* 48 (1999) 2398–2406.

Karadi, R.V., M.B. Palkar, E.N. Gaviraj, N.B. Gadge, V. Mannur, and K.R. Alagawadi (2008). Anti-urolithiatic property of -865. *Moring oleifera* root bark. *Pharm. Biology* 46: 861

Karim, N.U., U. S. A. A. Siddiq, M.R. M. Razak, M.K.M. Zainol and M.I. Abdullah (2018). Effects of Moringa leaves *(Moringa oleifera*) extraction on quality changes and melanosis of giant freshwater prawn *Macrobrachium rosenbergii* during chilled storage. *Italian J. Food security* 7:6846 – 153-157.

Karthika, S., M. Ravishankar, J. Mariajancyrani and G. Chandramohan (2013). Study of phytoconstituents from *Moringa oleifera* leaves. *Asian J. Pl. Sci. & Res.* 3(4); 63-69.

Kasolo, J.N., G.S. Bimanya, L. Ojok, J. Ochieng and J.W. Ogwal (2010). Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities. *J. Med. Plant Res.* 4(9): 753-757.

Kaur, G., M. Invally, R. Sanzagiri and H.S. Buttar (2015) Evaluation of the antidepressant activity of *Moringa oleifera* alone and in combination with fuoxetine. *J. Ayurveda Integr. Med.* 6:273–279. (https:// doi.org/10.4103/0975-9476.172384).

Kayani, M.Z., T. Mukhatar and M.A. Hussain (2012). Evaluation of nematicidal effects of *Cannabis sativa* L. and *Zanthoxylem alatum* Roxb. Against root-knot nematode, *Meloidogyne incognata*. *Crop Protection* 39: 52-56.

Khalaf, E.A.S., A.M. Naghib, L.E.M. Amin and F.M.M. Ibrahim. (2016). Biological effects of topical application of *Moringa oleifera* extract versus fluoride on uremic patients extracted teeth. *Int. J. Adv. Res.* 4(9): 1513-1520. (http://dx.doi.org/10.21474/IJAR01/1648).

Khan, D., M.J. Zaki and M. Azeem (2021). Foliar ornamentation and surface micromorphology of Doctor tree (*Moringa oleifera* Lam.) seedling – An accession of Karachi, Pakistan. *Karachi Univ. J. Science* 49(1-2): 83-94.

Kirtikar, K.R. and B.D. Basu (1975). *Moringa oleifera*. In: *Indian medicinal plants.* Vol. 1. (Eds. D. Dun, B. Singh and M.P. Singh). Bishen Singh Mahendrapal Singh Publishers. Dehra Dun, India. p. 676.

Kivevele, T. and Z. Huan (2015) Review of the stability of biodiesel produced from less common vegetable oils of African origin. *South Afr. J. Sci.* 111:01–07.

Korkina, L.G. and I.B. Afanas'ev (1997). Antioxidant and chelating properties of flavonoids. *Adv. Pharmacol*. 305: 151-163.

Kostyuk, V. A., A. I. Potapovich, E.N. Vladykovskaya, L.G. Korkina and I.B. Afanas'ev (2001). Influence of metal ions on flavonoid protection against asbestos-induced cell injury. *Arch. Biochem. Biophys*. 385:129-137

Kumar, S. (2017). Medicinal importance of *Moringa oleifera*: drumstick plant. *Indian J. Sci. Res.* 16 (1): 129-132.

Kurokawa M, A. Wadhwani, H. Kai, M. Hidaka, H. Yoshida, C. Sugita, W. Watanabe, K. Matsumo and A. Hagiwara (2016). Activation of cellular immunity in herpes simplex virus type 1-infected mice by the oral administration of aqueous extract of *Moringa oleifera* Lam., Leaves. *Phytother Res* 30:797–804. doi:10.1002/ptr.5580

Kwaghe, A.V. and A.G. Ambali (2009). Preliminary phytochemical screening of fresh and dried Moringa oleifera leaves and that of chloroform, ethylacetate and n-Butenol fractions. *African J. Online* (AJOL) 8(2): OR *Sahel J. Veterinary Sci.* 8(2):

Lacroix, M., R.A. Tillon and G. Ledercq (2006). P53 and breast cancer. An update. *Endocrine related Cancer*13 (2): 263-323.

Lambole, V. and U. Kumar (2012). Effect of *Moringa oleifera* Lam. on normal and dexamethasone suppressed wound healing. *Pac J. Trop. Biomed.* 2: 5219-23.

Lea M.A., T. Akinpelu, R. Amin, K, Yartagadda, B. Dayal and C. Desbordes (2012). Abstract 5439: inhibition of growth and induction of differentiation of colon cancer cells by extracts from okra (*Abelmoschus esculentus*) and drumstick (*Moringa oleifera*). *Cancer Res*. doi:10.1158/1538-7445.AM2012- 5439 (seen in Saini *et al.,* 2016)

Leone, A., F. Fiorillo, F. Criscuoli, S. Ravasenghi, L. Santagostini, G. Fico, A. Spadafranca, A. Battezzati, A. Schiraldi, F. Pozzi, A.di Lello, S. Filippini and S. Bertoli (2015). Nutritional characterization and phenolic profiling of *Moringa oleifera* leaves grow in Chad, Sahrawi Refuge Camp and Hait. *Int. J. Mol. Sci*. 16(8): 1893-1897. (http://doi.org/10.3390/ijms160818923).

Lui, R., J. Lui, Q. Huang, S. Lui, and Yueping Jiang (2021). *Moringa oleifera*: a systematic review of its botany, traditional uses, phytochemistry, pharmacology and toxicity. *J. Pharmacy and Pharmacology:* rgrab 131. (http://doi.org/10.1093/jpp/rgrab131).

Luqman, S., S. Srivastava, R. Kumar, A.K. Maurya and D. Chandal (2012). Experimental assessment of *Moringa oleifera* leaf and fruit for its antistress, antioxidant and scavenging potential using *in vitro* and *in vivo* assays. *Evidence-based Complementary and Alternative Medicine* (Hindawi Publ. Corp.) 12 pages (Doi; 10.1155/2012/519084)

Ma, Z.F., J. Ahmad, H. Zhang, I. Khan and S. Muhammad (2020). Evaluationof phytochemical and medicinal properties of Moringa (*Moringa oleifera* as a potential functional food. *South Afr. J. Botany* 129: 40-46. (http://doi.org/10.1016ljsajb.2018.12.002).

Mahajan, S.G. and A.A. Mehta (2008). Effect of *Moringa oleifera* Lam. Seed extract on ovalbumin-induced airway inflammation in Guinea pigs. *Inhalation Toxicology: Int. Forum for Respiraytory Research* 20 (10). 897-909. (http://doi.org/10.1080/08958370802027443).

Mahajan, S.G., A Banerjee and B.F. Chauhan (2009). Inhibitory effect of n-butanol fraction of *Moringa oleifera* Lam. seeds on Ovalbumin-induced airway inflammation in Guinea pig model of asthma. *Int. J. Toxicology Res. J. Recent Sci.* 1(3): 31-40.

Mahfuz, S. and X.S. Piao (2019). Application of Moringa (*Moringa oleifera*) as natural feed supplement in poultry diets. *Animals* 9: 431.

Mahmood, K.T., T. Mughal and I.U. Haq (2010). *Moringa oleifera*: a natural gift – A Review. *J. Pharma. Sci. & Res.* 2(11); 775-781.

Makkar, H.P. and K. Becker (1997). Nutrients and antiquity factors in different morphological parts of the *Moringa oleifera* tree. *J. Agric. Sci. 128*: 311-322.

Makkar, H.P.S. and K. Becker (1996). Nutritional value and anti-nutritional components of whole and ethanol extracted *Moringa oleifera* leaves. *Animal Feed Sci. & Tech.* 63(1-4): 211-228.

Makkar, H.P.S. and K. Becker (1999). Plant toxins and detoxification methods to improve feed quality of tropical seeds. *Asian Australasian J. of Animal Science* 12(3): 467-480.

Malhotra, S.P.K. and T.K. Mondal (2018). Phytochemical screening and *in vitro* antibacterial activity of *Moringa oleifera* (Lam.) leaf extract. *Archives of Agriculture and Environmental Sci.* 3(4): 367-372. (http://doi.org/10.268321/24566632.2018.030406).

Manguro, L.O. and P. Lemmen (2007). Phenolics of *Moringa oleifera* leaves. *Nat. Prod. Res.* 1: 56-68.

Manzoor, M., F. Anwar, T. Iqbal and M.I. Bhanger (2007). Physico-chemical characterization of *Moringa concanensis* seeds and seed oil. *J. Am. Oil Chem. Soc*. 84: 413-419.

Maqsood, M., R. Qureshi, M. Arshad, M.S. Ahmed and M. Ikram (2017). Preliminary phytochemical screening, antifungal and cytotoxic activities of leaves extract of *Moringa oleifera* Lam. from salt range, Pakistan. *Pak. J.* Biol. 49(1): 353-359.

Martin, C., G. Martin, A. Garcia, T. Fernandez, E. Hernandez and J. Puls (2013). Potential application of *Moringa oleifera.* A Critical Review. *Pastos Y Forrajes* 36(2); 150-158.

Mbikay, M. (2012). Therapeutic potential of Moringa oleifera leaves in chronic hyperglycemia and dyslipidemia: a review. *Front. Pharmacol.* 3 (2012) 1–12.

Mehta, A. and B. Agarwal (2008). Investigation inton the mechanism of action of *Moringa oleifera* for its antiasthamatic activity. *Oriental Pharmacy and Experimental Medicine* 8(1): 24-31.

Mehta S, P.K. Rai, N.K. Rai, A. Rai. K, Bicanic D, Watal G. (2011a). Role of Spectral Studies in detection of antibacterial Phytoelements and Phytochemicals of *Moringa oleifera*. *Food Biophysics* 6:497–502.

Mehta, J., A. Shukla, V. Bukhariya and R. Charde (2011b). The magic remedy of *Moringa oleifera*: An overview. *Int. J. Biomed Adv. Res.* 2(6): 215-227.

Mehta, K. R. Balaraman, A.H. Amin, P.A. Bafna and O.D. Gulati (2003). Effect of fruits of *Moringa oleifera* on the lipid profile of normal and hypercholesterolemia rabbits. *J. Ethnopharmacology.* 86: 191-195.

Meireles, D. J. Gomes, L. Lopes, M. Hinzman and J. Machado (2020). Review of properties, nutritional and pharmaceutical application of *Moringa oleifera*: Integrative approach on conventional and traditional Asian medicine. *Adv. Trad. Medicine* 20: 495-515. (http://doi.org/10.1007/s13596-020-00468-0).

Metwally, F.M., H.M. Rashead, H.H. Ahmed, A. A. Mahmond, E.R.A. Raouf and A, M, Abdalla (2017). Molecular mechanisms of the antiobesity potential effect of *Moringa oleifera* in the experimental model. *Asian Pacific Journal of tropical Biomedicine* 7(1): 214-223.

Mishra, G., P. Singh, R. Verma, S. Kumar, S. Srivastava, K.K. Jha and R.L. Khosa (2011). Traditional uses, phytochemistry and pharmacological properties of *Moring oleifera* plant: An Overview. Der *Pharm. Lett.*. 3 (2): 141-164.

Mohamed, N.B., A.H. Mohamed, N.A. Abu-Aita, S.M. Nasr, S.A. Nasser and K.A. Ahmed (2020). Prophylactic role of *Moringa oleifera* leaves extract against lead toxicity in rats. *Adv. Anim. And vater. Sciences* 8(11): 1129-1141. (Doi: http://dx.doi.org/1017582/journal.aaves/202018.11.1129.1141).

Moyo, B., P.J. Masika, A. Hugo and V. Muchenje (2011). Nutritional characterization of Moringa (*Moringa oleifera* Lam.) leaves. *Afr. J. Biotech.* 10:12925-12933.

Moyo, B., S. Oyedemi, P.J. Mesika and V. Muchenje (2012). Polyphenolic content and antoxidant properties of *Moringa oleifera* leaf extracts and enzymatic activity of liver from goats supplementes with *Moringa oleifera* leaves/sunflower seed cake. *Meat Sci.* 91: 441-447.

Mukunzi, D., J. Nsor-Atindana, Z Xiaoming, A. Gahungu, E. Karangwa and G. Mukamurezi (2011). Comparison of volatile profile of *Moringa oleifera* leaves from Rwanda and China using HS-SPME. *Pakistan J. Nutr.*, 10, 602-608. https://doi.org/10.3923/pjn.2011.602.608.

Murakami A, Y. Kitazono, S. Jiwajinda, K. Koshimizu and H. Ohigashi (1998). Niaziminin, a thiocarbamate from the leaves of *Moringa oleifera*, holds a strict structural requirement for inhibition of tumor-promoter-induced Epstein-Barr virus activation. *Planta Med.* 64: 319–323. (Doi: 10.1055/s-2006-957442).

Muriel, G. (2010). Moringa and global warming. (muriella.wordpress.com/2012/04/16/Moringa-global warming-and you-murriell'a corner).

Murslain, M., N. Javed, S.A. khan, A. Khan, H.U. Khan, H. Abbas and M. Kamran (2014). Combined efficacy of *Moringa oleifera* leaves and a fungus, *Trichoderma harzianum*, against *Meloidogyne javanica* on eggplant. *Pak. J. Zool.* 46(3): 827-832.

Muyibim, S.A. and L.M. Evison. (1994). *Moringa oleifera* seeds for softening hard water. *Water Res.* 29 (4): 1099-1105.

Nadeem M., M. Abdullah, I. Hussain, S. Inayat S, A. Javid and Y. Zahoor (2013). Antioxidant potential of *Moringa oleifera* leaf extract for the stabilisation of butter at refrigeration temperature. *Czech. J. Food Sci.* 31(4): 332-339. https://doi. org/10.17221/366/2012-CJFS.

Nadeem, M. and M. Imran (2016). Promising features of *Moringa oleifera* oil: recent updates and perspectives. *Lipid in health and diseases* 15: 212. (Doi: 10.1186/s12944-016-0379-0)

Nadeem, M., R. Ullah and A. Ullah (2016). Improvement of the physical and oxidative stability characteristics of ice cream through interesterified *Moringa oleifera* oil. *Pak J Scientif. Industrial Res. Ser B: Biol. Sci.* 59(1): 38-43.

Nahar, S., F.M. Faisal, J. Iqbal, M.M. Rahman and M. A. Yousuf (2016). Antiobesitya activity of *Moringa oleifera* leaves against high fat-diet- induced obesity in rats. IJBCP (*Int. Journal of Basic & Clinical pharmacology*. 5 (4). (http://dx.doi.org/10.18203/2319-2003.ijbcp 20162427).

Nath D., N. Sethi, R.K. Singhand and A. K. Jain. (1992). Commonly used Indian abortifacient plants with special reference to their teratologic effects in rats. *J. Ethnopharm*. 36:147-154.

Nathaneil, E.U. (2021). *Efficacy of Moringa oleifera and Moringa stenopetala leaves on growth performance, haemato-biochemical profiles and gut microbiota in Broiler chicken.* Ph.D. Thesis, Kenya Methodist University. June 2021. Kenya. Xvi + 255 Pp.

Nayak, G., A. Rao, P. Mullick, S. Mutalik, S.G. Kalthur, S.K. Adiga and G. Kalthur (2020). Ethanolic extract of *Moringa oleifera* leaves alleviate cyclophosphamide-induced testicular toxicity by improving endocrine function and modulating cell specific gene expression in mouse cells. *Ethnopharmacology* 259:112922 (Doi: 10.1016/j-jep.2020.112922)

Nayak, G., A. vadinkar, S. Nair, S.G. Kalthur, A.S. D'souza, P.K. Shetty, S. Mutalik, M.M. Shetty, G. Kalthur and S.K. Adiga (2016). Sperm abnormalities induced by pre-pubertal exposure to cyclophosphamide are effectively mitigated by *Moringa oleifera* extract. *Andrologia* 48 (2): 125-136. (Doi: 10.1111/and.12422.Epub 2015 Apr22).

Nda Bigengeser, A. and K.S. Narasiah (1998). Use of *Moringa oleifera* seeds as primary coagulant in wastewater treatment. *Environ. Technol*. 19; 789-800.

Ndiaye, M., A. M Dieye, F Mariko, A Tall, Sall Diallo and B. Faye (2002). Contribution a l'etude de l'activite anti-inflammatory de *Moringa oleifera* (Moringaceae). *Dakar Med*. 47:210.

Nijveldt, R.J., E.V. Nood, D. EC V. Hoorn, P.G. Boelens and K.V. Norren (2001). Flavonoids: a review of probable mechanism of action and potential applications. *Am. J. Clinical Nutrition*. 74:418.

NISC (National Institute of Science Communication) (1998). *The Wealth of India.* Raw Materials Vol. VI (L & M). CSIR, New Delhi, India.

Niziot-Tukaszewska, Z., D. Furman-Toczek, T. Bujak, T. Wasilewski and Z. Hordyjewicz-Baran (2020). *Moringa oleifera* L. extracts as bioactive ingredients that increases safety of body wash cosmetics. *Dermatology Research and Practice*. Article ID 8197902. 14 Pages. (http://doi.org/10.1155/2020/8197902).

Njoku, O.U. and M.U. Adikwu (1997). Investigation on some physico-chemical antioxidant and toxicological properties of *Moringa oleifera* seed oil. *Acta Pharmaceutica Zagreb* 47 (4): 287-290.

Nweze, N. Onyekwere and I. Nwafor Felix (2014). Phytochemical, proximate and mineral composition of leaf extracts of *Moringa oleifera* Lam. from Nsukka South-Eastern Nigeria. *IOSR Journal of Pharmacy and Biological Sciences* 9(1): 99-103.

of trihalomethane (THM) precursors and iron from drinking water. In: *Water science Technology: Water supply* vol.9 (6): 707-714. (2009). (http://doi.org/10.2166/ws.2009.671).

Ojiako, E.N. (2014). Phytochemical analysis and antimicrobial screening of *Moringa oleifera* leaves extract. *Int. J. Engg. & Science* (IJES) 3(3): 32-35.

Okah, R. and W. Carnelius (2019). Phytochemical analysis of *Moringa oleifera* (leaves and Flowers) and the functional group). *Global Scientific Journals* 7(6); 41-51.

Okumu, M.O., J.M. Mbaria, L.W. Kanja, D.W. Gakuya, S.G. Kiama and F.O. Ochola (2016). Phytochemical profile and antioxidant capacity of leaves of *Moringa oleifera* (Lam.) extracted using different solvent systems. *Journal of Pharmacognosy and Phytochemistry* 5(4): 302-306.

Oladeji, O.S., K.A. Odelade and J.K. Oloke (2020). Phytochemical screening and antibacterial investigation of *Moringa oleifera* leaf extracts. *Afr. J. Sci. Tech Innovation and Development* 12 (1). (http://doi.org/10.1080/20421338.2019.1589082)

Olajide, M.C., N.B. Izuogu, R.A., Ap-alowo and H.S. Baba (2018). Evaluation of nematicidal and antifungal activity of aqueous extracts of *Moringa oleifera* leaves and seeds in cucumber field. *Cercetári Agronomics in Maldovo* Vol. LI, N. 4 (176). 47-59. (Doi: 10.2478/cerce-2018-0035).

Olaoye, A.B., C.A. Ologunde, O.R. Molehin and I. Nwankwo (2021). Comparative antioxidant analysis of *Moringa oleifera* leaf extracts from Southwestern States in Nigeria. *Future J. Pharmaceutical* Sciences 7: 68. Pages 1-15. (http://doi.org/10.1186/s43094=021-00204-8).

Oluduroa, O.A., B.I. Aderiye, J.D. Connolly, E.T. Akintayo and O. Famurewa (2010) Characterization and Antimicrobial Activity benzyl thiocarboxamide; a Novel Bioactive Compound from *Moringa oleifera* Seed Extract. *Folia Microbiology* 55:422–426

Oluwatayo, J.I., C.I. Jidare and A. Nwankiti (2019). Nematidal effect of some botanical extracts for the management of *Meloidogyne incognata* and on growth of tomato. *Asian J. Agricultural and Horticultural Research* 4(2): 1-8. Article No. AJAHR.50193.

Omotesho, K.F., F.E. Sola-Ojo, T.R. Feyeye, R.O. Babatunde, G.A. Otunola and T.H. Aliya (2013). The potential of *Moringa* tree for poverty alleviation and rural development: review of evidence on usage and efficacy. *Int. J. Development and Sustainability* 2: 799-813.

Osarughe, I.P., D.E. Omonigho, O.N. Frances, U. Eseosa (2020). Effect of *Moringa oleifera* seeds on the microbiological and physico-chemical parameters of industrial and Kitchen effluents. *PSM Biol. Res.* 5(1): 1-13.

Padayachee, B. and H. Baijnath (2012). An overview of the medicinal importance of Moringaceae. *J. Medic. Pl. Res*. 6(48): 5831-5839.

Padmalochana, K. (2018). Anti-inflammatory activity and phytochemical analysis of *Moringa oleifera* ethanol and acetone leaves extract. J. Drug Delivery and therapeutics 8 (6-s). JDDT online. (http://doi.or/10.22270/jddt.v8i6-s.2129).

Paikra, B.K., H. Kumar, J. Dhongade and B. Gidwani (2017). Phytochemistry and pharmacology of *Moringa oleifera* Lam. *J. Pharmacopuncture* 20(3): 194-200.

Palada, M.C. and L.C. Chang (2003). Suggested cultural practices for *Moringa*. AVRDC International Cooperators' Guide. AVRDC Pub. 03-545.

Pandey, V.N., V. Chauhan, V.S. Pandey, P. P. Upadhayaya and O.R. Kopp (2019). *Moringa oleifera* Lam. A biofunctional edible plant from India. Phytochemistry and Medicinal Properties *J. Plant Studies* 8(1): 10-19.

Papoola, J.O., O.S. Aworunse, O.L. Oyesola, O.O. Akinnola, and O.O. Obeme (2020). A systematic review of pharmacolical activities and safety of *Moringa oleifera. J. Herbmed Pharmacology* 9(3): 174-190. (doi:10.34172/jnp.2020.24).

Pakade, V., E. Curkrowska and l. Chimuka (2013). Comparison of antioxidant activity of *Moringa oleifera* and selected vegetables in South Africa. *South Afr. J. Sci. 109*(3-4): 1-5. (Doi: 10.1590/sajs.2013/1154).

Pari, L. and N.A. Kumar (2002). Hepatoprotective activity of *Moringa oleifera* on antitubercular drug-induced liver damage in rats. *J. Medicinal food* 5(3): 171-177. (Doi: 10.1089/10466200260398206).

Pinto, N.A.V.D., V.D. Carvalho, A.D. Corrêa and A.O. Rios (2001). Avaliação de fatores antinutricious das fochas da taioba (*Xanthosoma sagittifolium* Schoot). *Cîencia e Agrotecnologia* 25(3): 601-604.

Pollard, D.J.t., F.F. Thompson and G.L. McConnachie (1995). Microporous carbon from *Moringa oleifera* husk for water purification in less developed countries. *Water Res.* 29(1): 337-347.

Pontual, E.V., B.F. Carvalho, R.S. Bezerra, L.L. Coelho, T.H. Napoleão and P.M. Paiva (2012). Caseinolytic and milk-clotting activities from *Moringa oleifera* flowers. *Food Chem.* 135(3): 1848-1854 (Doi: 10.1016/jfoodchem.2012.06.087)

Poumaye, N., J. Ma Bingui, P. Lutgen and L.M. Bigan (2012). Contribution to the clarification of surface water from *Moringa oleifera*: Case of M'Poko River to Bangui, Central African Republic. *Chem. Engg. Res. Des.* 90: 2346-2352.

Prabhu, K., K. Murugan, A. Nareshkumar, W. Ramasubramanian and S. Bragadeeswaran (2011). Larvicidal and repellant potential of *Moringa oleifera* against malarial vector *Anopheles stephensi* Liston (Insecta: Diptera. Culidae). *Asian Pacific J. Tropical Biomedicine* 1-12: 124-129. (Doi: 10.1016/s2221-1691(11)60009-9).

Prakash A.O., S. Pathak, S. Shukla and R. Mathur (1988) Pre and Post-implantation changes in the uterus of rats: Response to *Moringa oleifera* Lam. Extract. *Anc. Sci. Life* 8:49-54.

Prakash A.O., S. Pathak, S. Shukla and R. Mathur (1987) Uterine histoarchitecture during pre- and post-implantation periods of rats treated with aqueous extract of *Moringa oleifera* Lam. *Acta Eur. Fertil.* 18:129-135.

Pritchard, M., T. Craven, T. Mkanawire, A. S. Edmosnon and J.G. O'Neil (2010). A comparison between *Moringa oleifera* and chemical coagulants in the purification of drinking water- An alternative sustainable solution for developing countries. *Physics and Chemistry of the Earth* 35: 798-805. (DOI: 10.1016/jpee.2010.07.014)

Pritchard, M., T. Mkandawire, A. Edmondson, and J.G. O'Neil (2009). Potential of using plant extracts for purification of shallow well water in Malawi. *Phys. Chem. Earth* 34: 798-805.

Prithiviraj, E. and G. Sumathy (2021). A review on pharmacological properties of *Moringa oleifera. Net Volatiles & Essent. Oils* 8(5): 340-355.

Radovich, T. (2011). Farm and forestry production and marketing profile for Moringa (Moringa oleifera). In: Specialty crops for Pacific island agroforestry. (Ed. C.R. Elevitch). *Permanent Agriculture Resources* (PAR).

Ramachandran, C., K.V. Peter, and P.K. Gopalakrishnan (1980). Drumstick (*Moringa oleifera*): A multipurpose Indian vegetable. *Economic Botany* 34(3): 276-283.

Randriam Boavonjy, J.I., M. Rao, P. Pacaud, G. Larand and A. Tesse (2017). Moringa oleifera seeds attenuates vascular oxidative and nitrosative stresses in spontaneously hypertensive rats. *Oxidative Medicine and Cellular Longevity* (Hindawi). Article ID 4129459 (10 pages). (http://doi.org/1o.1155/2017/4129459).

Rani, E.A. and T. Arumugam (2017). *Moringa oleifera* (Lam.): A nutritional powerhouse. *J. Crop and Weed*. 13(2): 238-246.

Rani, K.C., N. Parfati, N.I.K. Jayani, I.M.A. Kurniawan and N.P.W. Kristiani (2021). The development of *Moringa* leaves effervescent granules with effervescent agent of citric acid and sodium bicarbonate. *Pharmaciana* 11 (2): 225-238.

Rao, A.V., P.U. Devi and R. Kamath (2001). In vivo radioprotective effect of *Moringa oleifera* leaves. Indian J. Experimental Biology 39: 858-863.

Rao, K.N.Y., K. Gopalakrishnan, V. loganathan and S. Shanmuganathan (1999). Antiinflammatory activity of *Moringa oleifera* lam. *Ancient Science of Life* 18(3-4): 195 – 198.

Rashid, U. F. Anwar, B.R. Moser and C. knothe (2008). *Moringa oleifera* oil: a possible source of biodiesel. *Bioresource Tech.* 99: 8175-8179.

Razis, A.F.A., M.D. Ibrahim and S.B. Kntayya (2014). Health benefits of *Moringa oleifera*: Mini Review. *Asian Pac. J. Cancer Prev.* 15(20): 8571-8576.

Reddy, D, H. K., Y. Harinath, K. Seshaiah and A.V.R. Reddy (2010 a). Biosorption of Pb (II) from aqueous solution using chemically modified *Moringa oleifera* tree leaves. *Chem. Engg. Journal* 162 (2): 626-634. (Doi: 10.1016/jeej.2010.06.010)

Reddy, D.H.K., K. Seshaiah, A.V. Reddy, M.M. Rao and M.C. Wang (2010 b). Biosorption of aqueous solutions by Moringa oleifera bark: equilibrium and kinetic studies. *J. Hazardous material* 174 (1-3): 831-838. (DOI: 10.1016/j. jhazmat2009.09.128).

Redha, A.A., S. Perna, A. Reva, G. Petrangolini, G. peroni, M. Nichetti, G. Ianello, M. Naso and M.A. Faliva (2021). Novel insights on antiobesity potential of the miracle tree, *Moringa oleifera*: A systematic review. Journal of functional Foods 84 (2021)104600. (http://doi.org.10.1016/j.jff2021.104600).

Refaat, M.M., M.E. Mahrons, R.M. El-Ashry and A.M. El-Marzoky (2020). Nematicidal properties of commercial seed oils of certain medicinal plant on egg hatching and juvenile mortality of the root-knot nematode, *Meloidogyne incognata* in vitro. *Zigazig J. Agric. Res.* 47(2): 487-497.

Rezende, D., L. Nishi, P.F. Coldebella, M.F. Silva, M. F. Viera, A.M.S Vieira, R. Borgamasco and M. R. Fagundes-klen (2016). Groundwater nitrate Contamination: Assessment and treatment using *Moringa oleifera* Lam. seed extracts and activated carbon filtration. *The Canadian J. Chemical Engineering* 94 (4): 725-732. (Doi: 10.1002/cjce.22442).

Rizvi, M. A. and S. Abid Ali (2016). Medicinal flowers of Pakistan. *Int. Journal of Advanced Research* 4(2); 1313-1341.

Rizvi, M.A. (1998). Medicinal flowers of Pakistan. Part III. Horticultural Society of Pakistan, Karachi. 48-52.

Rubio-Sanz, L., C. Dorca-Fornell, M. Fornos, E. Navarro-León and M.C. Jaizme-Vega (2021). Phytochemical characterization of *Moringa oleifera* leaves. Herba polonica: Int. J. edited by Institute of Natural bibres and Medianal Plants. Natl. Res Int. Vol. 67(3): 19-26. (Doi: 10.2478/hepo-2021-0019).

Saadabi, A.M. and Z.A. Abu (2011). An in vitro antimicrobial activity of *Moringa oleifera* L. seed extract against different groups of microorganisms. *Asian J. Basic & Appl. Sci.* 5: 129-134.

Safitri, R. and R. Renaningsih, (2021). Role of *Moringa oleifera* leaf extract in increasing haemoglobin levels in pregnant rats with Anemia. *J. Health Sciences* 14(1): 8-13. (http://doi.org/10.33086/jhs.v14i.1296).

Saini, R.K., I. Sivanesan and Young-Sookeum (2016). Phytochemicals of *Moringa oleifera:* a review of their nutritional, therapeutic and industrial significance. 3Biotech 6: 203. (DOI: 10.1007/s13205-016-0526-3)

Sajid, A., L. Naz, A. Mughal, G. Yasmeen, N.I. Khan and S. Sohail (2020). Antioxidative effects of *Moringa oleifera* seed oil against oxidative stress induced by alloxan in rats. *Int. J. of Endorsing Health Sci. Res.* 8(4): 257-264. (Doi.10.29052/IJEHSR.v8. i4.2020.257-264).

Salah, N., N. J. Miller, G. Paganga, L. Tijburg, G. P. Bolwell and C. Rice-Evans. (1995). Polyphenolic flavanols as scavengers of aqueous phase radicals and as chain-breaking antioxidants," *Archives of Biochemistry and Biophysics*, 322 (2): 339–346.

Saleem, R. (1995). *Study of Chemical Constituents of Moringa Oleifera Lam*. Ph.D. thesis, University of Karachi, Karachi.

Sanchez-Martin, J., K. Ghebremichael and J. Beltian-Heredia (2010). Comparison of single step and two step purified coagulants from *Moringa oleifera* seed for turbidity and DOC removal. *Bioresource Technology* 101(15):6259-6261 (Doi: 10.1016/j.biotech, 2010.02.072).

Sankhalkar, S. and V. Vernekar (2016). Quantitative and qualitative analysis of phenolic and flavonoids content in *Moringa oleifera* Lam. and *Ocimum tenuflorum* L. *Pharmacogn. Res*. 8: 16-21. (Doi:10.4103/0974-8490.171095).

Santos Bazanella, G.C., G.F. Silva, A.M.S. Viera and F. Bergamesco (2008). Fluoride removal from water using combined *Moringa oleifera* / ultrafiltration process. *Water Air Soil Pollution* 223: 6083-6093.

Scalbert A., C. Manach, C. Morand, C. Remésy and L. Jiménéz (2005). Dietary polyphenols and the prevention of diseases. *Critical Reviews in Food Science and Nutrition*, 45 (4): 287– 306.

Shamim, S. Ahmed and L. Fatima (2018). Medicinal properties of *Moringa oleifera* (Sahajana): A Review. *The Pharma Innovation J.* 7(10): 311-316.

Shanmugavel, G., K. Prabhakaran and B. George (2018). Evaluation of phytochemical constituents of *Moringa oleifera* (Lam.) leaves collected from Punducherrry Region, South India. *Int. J. Zool. & Appl. Biosci.* 3(1): 1-8.

Sharma, V.R., R. Paliwal and S. Sharma (2011). Phytochemical analysis and evaluation of antioxidant activities of hydro0methanolic extract of *Moringa oleifera* Lam. *J. Pharm.Res*. 4(2): 554-557. (Seen in Paikra *et al*., 2017).

Shaw, B.P. and P. Jana (1982). Clinical assessment of Sigru (*Moringa oleifera)* on Mutrakrichhra (lower urinary tract infection) *Nagarjun*: 231-235.

Shousha, W.G., W.M. Aboulthana, A.H. Salama, M.H. Saleh and E.A. Essawy (2019) Evaluation of the biological activity of *Moringa oleifera* leaves extract after incorporating silver nano-particles, *in vitro* study. *Bull. National Res. Centre* 43, Article # 212. (http://doi.org/10.1186/s42269-019-0221-8).

Shukla S. (1988). Antifertility profile of the aqueous extract of *Moringa oleifera* roots. *J. Ethnopharm* 22(1):51-62. 67.

Siddhuraju, P. and K. Becker (2003). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. *J Agric. Food Chem.* 51:2144-2155.

Sim, Ho-Cheol, H. Joung, Hyun-Jin Do, Hee-Hoon Kim and Myoung-Sool Do (2018). Studies on nutritional components, safet and physiological active efficacy of *Moringa oleifera* leaf. *Korean J. Food Nutrition* 31 (1): 1-16.

Singh B.N., B.R. Singh, R.L. Singh D. Prakash, G. Upadhyay and H.B. Singh (2009). Oxidative DNA damage protective activity, antioxidant, and anti-quorum sensing potentials of *Moringa oleifera*. Food Chem. Toxicol. 47:1109–1116. (Doi:10.1016/j.7ct.2004.01.034).

Singh, L., Jyoti and J. Singh (2019). Medicinal and nutritional values of drumstick tree (*Moringa oleifera)* - A Review. *Int. J. Current Microbiology and Appl. Sciences* 8(5): 1965-4974.

Singh, P., M. Parmar and V. K. Gupta (2021). Phytoconstituents and medicinal potential of *Moringa oleifera, Int. J. Sci., Development and Res.* (IJSDR) 6(2): 205-212.

Singh, U., C. Dwivedi, U. Kulsum, N. Verma, S. Saraf and D.K. Pradhan (2017). Phytochemistry and Medicinal uses of *Moringa oleifera*: An Overview. *J. Drug Deliveryand Therapeutic* 7(6): 104-116. (http://dex.doi.org/10.22270/iddt.v7i6.1522).

Sinha, S, N., D. Paul and K. Biswas (2016). Effects of *Moringa oleifera* Lam. and *Azadirachta indica* A. Juss. Leaf extract in treatment of tannery effluent. *Our Nature* 14 (1): 47-53. (Doi: http://dx.org/10.3126/on.14i1.16440).

Sonica, S. Dhiman, T.G. Singh, G. Arora and S. Arora (2020). *Moringa* gum: A comprehensive review on its physico-chemical and functional properties. *Plant Archives* 20(1): 3794-3805.

Sreedam, C.D., Kaiser H, Jahan BI, Sultana S, Md. Islam S. (2010). *In vitro* antioxidant activity of different parts of the plant, *Diospyros discolor*. *Res J Agric Biol Sci.* 6:472-475.

Sridharan, S., Y. Chen, D. Saravaran, K.M. Sindram and L.Y. Latha (2011). Extraction, isolation and characterization of bioactive compounds from plant extracts. *Afr. J. of Traditional, Complementary and alternative* Medicines 8(1): 1-10.

Srivastava, M., P.K. Dhakad, B. Srivastava (2020). A review on medicinal constituents and therapeutic potential of *Moringa oleifera*. *Universal Plant Science* 8(2): 22-33.

Stevens, G.C., K.P. Baiyeri and O. Akinnnagbe (2013). Ethno-medicinal and culinary uses of *Moringa oleifera* Lam. in Nigeria. *J. Medic. Plant. Res.* 7(13): 799-804.

Subramonie, S., N. Suryadevara, B. Ganapathy and T. Gokila Devi (2020). Molecular activities in *Moringa oleifera* Lam. Review. *Int. J. of Research in Pharmaceutical Sciences* 11 (1): 140-147. (http://doi.org/10.26452/ijrps.v11i1.1798).

Sudha, P., S.M.B. Asdaq, S.S. Dhamingi and G.K. Chandrakala (2010). Immunomodulatory activity of methanolic extract of *Moringa oleifera* in animals. *Indian J. Physiol. Pharmacol*. 54(2): 133-140.

Sulaiman, M.R., Z.A. Zakria, A.S. Bujarimin, M.N. Somchit, D.A. Israf and S. Moin (2008). Evaluation of *Moringa oleifera* aqueous extract for anti-nociceptive and anti-inflammatory activities in animal models. *Pharmaceutical Biology* 46(12): 838-845.

Sutar, N.G., C.G. Bonde, V.V. Patil, S.B. Narkhede, A.P. Patil, and R.T Kakade (2008). Analgesic activity of seeds of *Moringa oleifera* Lam. *Journal of Green Pharmacy* 2(2): 108-110.

Sutherland, J.P., G.K. Folkard and W.D. Grant (1989). "Seeds of *Moringa* species as naturally- occurring flocculants". *Sci. Technology and development* 7(3): 191-197.

Swathi, S. (2016). Phytochemical screening and TLC studies of *Moringa oleifera*. Their antibacterial and antioxidant activities. *Int. J. Current Pharmaceutical Research* 8(1): 46-49.

Swati, A.K. Virk, C. Kumari, A Ali, P. Garg, P. Thakur, C. Attri and S. Kulshrestha (2018). *Moringa oleifera* – A never die tree: An Overview. *Asian J. of Pharmaceutical and clinical Research* 11 (12): 57-65.

Tahir, M.A., M.A. Bin Nyeem, M.M. Ahammed, M.M. Hossain and M.N. Islam (2017). *Moringa oleifera* (Shajna): the wonderful indigenous medicinal plant. *Asian J. Medical & Biol. Res.* 3(1): 20-30.

Tahkur, R.S., G. Soren, R.M. pathapati and M. Pruchineni (2016). Diuretic activity of *Moringa oleifera* leaves extract in Swiss albino rats. *The Pharma Innovation Journal* 5(3): 8-10.

Talreja, T. (2010). Screening of crude extracts of flavonoids of *Moringa oleifera* against bacteria and fungal pathogen. *J. Phytology* 2 (11): 31-35.

Teh, C.Y., T.Y. Wu (2014). The potential use of natural coagulants and flocculants in the treatment of urban waters, Chem. Engg. Transactions 39. (Doi: 10.3303/CET1439268). A publication of AIDIC. The Italian Association of Chemical Engineering-www.aidic.it/cet.

Teixeira, E.M.B., M.R. B. Carvalho, V.A. Neves, M.A. Silva and L. Arantes-Pereira (2014). Chemical charctersitics and fractionation of proteins from *Moringa oleifera* Lam. Leaves. *Food Chem.* 147: 51-54. (http://dex.doi.org/10.1016lj.foodchem2013.09.135).

Thurber, M.D. and J.W. Fahey (2010). Adoption of *Moringa oleifera* combat under nutrition viewed through the lens of the "diffusion of innovations" theory. *Eco. Food Nut.* 48: 1-13.

Tiloke, C., A. Phulukdaree and A.A. Chuturgoon (2013). The antiproliferative effect of *Moringa oleifera* crude aqueous leaf extract on cancerous human alveolar epithelial cells. *BMC Complement. Altern. Med.* 13:226. (Doi: 10.1186/1472-6882-13-226).

Torres-Castillo, J.A., S.R. Sinagawa-Gracía, G.C.C. Martínez-Avila, A.B. López-Flores, E.F. Sánchez-Gonźalez, V.E. Acquire-Arzola, R.I. Torres-Acosta, O. Olivares-Sáenz, E. Osorio-Hernández and A. Gutiérrez-Diez. (2013). Moringa oleifera: Phytochemical detection, antioxidanta, enzymes and atifungal properties. Phyton 82: 193-202.

Turner, T.B., P. Rojas-Silva, A. Paulev, I. Raskin and C. Waterman (2015). Direct and indirect antioxidant activity of polyphenols – and isothiocyanate-enriched. *J. Agric. Food Chem.* 643(%): 1505-1513.

Udofia, N.E., O.J. Misonge, M. Mworia, N. William and M. G. Apiri (2020). Chemical composition of *Moringa oleifera* Lam. and *Moringa stenopetala* Bac. Leaves from Kenya. *Int. J. Pl. Res.* 10(1): 1-10. (doi: 10.5923/j.plant.20201001.01)

Ujah O.F., I.R. Ujah IR, J.T. Johnson, V.S. Ekam and E.C.C. Udenze (2013). Hepatoprotective property of ethanolic leaf extract of *Moringa oleifera* on carbon tetrachloride (CCl4) induced hepatotoxicity. Scholar Research Library. *J. Nat. Prod. Plant* 3:15–22

Uniugbe, C.A., Henri A. Okeri, O, Erharvi, E.E. Oghenero and D.A. Obamedo (2014). Phytochemical and antioxidant evaluation of *Moringa oleifera* (Moringaceae) leaf and seed. *J. Pharmacy & Bioresources* 11 (2): 51-57.

Valdez-Solana, M. A., V.Y. Meija – Garcia, A. Tellez-Valencia, G. Garcia-Arenas, J. Salas-Pancheco, J.J. alba-Romero and E. Sterra-Campos (2015). Nutritional content and elemental and phytochemical analyses of Moringa oleifera grown in Mexico. *J. Chem*. Article ID 860381 (http://doi.org/10.1155/2015/860381).

Velázquez-Zavala, M.V., T.E. Peón-Escalante, R.Z. Baupista and M.A. Jiménez-Arellanes (2016). Moringa (*Moringa oleifera* Lam.): Potential uses in agriculture, industry and medicine, *Revista Chapingo serie horticultura* vol. XXII (No. 2). (Doi: 10.5154/r.rehsch.2015.07.018).

Villafuerte, L.R. and L. Villafuerte-Abonal (2009). Data taken from the forestry agency of Japan in Moringa. Malunggay Philippines. Apples of gold publishing, Singapore, p. 240.

Villarruel-Lopez, A., D.A. López-de la Mora, O.D. Vazquez-Paulino, A.G. Puebla – Mora. Ma R. Torres-Vitela, L.A. Guenero-Quiroz and K. Nuño (2018). Effect of *Moringa oleifera* consumption on diabetic rats. *BMC complementary and alternative medicine* 18: 127 (http://doi.org/10.1186/s12906-018-2180.2)

Villasenor, I.M., P. Finch, C.Y. Lim-Sylianco and F. Daysit (1989a). Structure of a mutagen from roasted seeds of *Moringa oleifera*. *Carcinogenesis* 10: 1085-1087.

Villasenor, I.M., P. Finch, C.Y. Lim-Sylianco and F. Daysit (1989b). Mutagens from roasted seeds of *Moringa oleifera*. *Mutation research* 224: 209-212.

Vivekananthan, D.P.; M.S. Penn, S.K. Sapp, A. Hsu and E.J. Topol. (2003). Use of antioxidant vitamins for the prevention of cardiovascular disease: Meta-analysis of randomized trials. *Lancet* 361, 2017–2023.

Warrier P.K., V.P.K. Nambiar and C. Ramankutty (2010) *Indian Medicinal Plants: A Compendium of 500 species*. Vol. 4. University Press. Kottakal, India, pp 303–306.

Waterman C, P. Rojas-Silva, T.B. Tumer, P. Kuhn, A.J. Richard, S. Wicks, J.M. Stephens, Z. Wang, R. Myanalt, W. Cafalu, and T. Raskin (2015). Isothiocyanate rich *Moringa oleifera* extract reduces weight gain, insulin resistance, and hepatic gluconeogenesis in mice. Mol. Nutr. Food Res. 59:1013–1024. doi:10.1002/mnfr. 201400679

Wright, E., J.L. Scism-Bacon and L.C. Glass (2006). Oxidative stress in type 2 diabetes: the role of fasting and postprandial glycaemia. *Int. J. Clin. Pract.* 60: 308–314.

Xiao, X., J. Wang, C. Meng, W. Liang, T. Wang, B. Zhou, Y. Wang, X. Luo, L. Gao and L. Zhang (2020). *Moringa oleifera* Lam. and its therapeutic effects in immune disorders. Front. Pharmacology 11. Article 566783. Pages 1-9. (Doi: 10.3389/fphar.2020.566783).

Yadav, N.R., M. Jain, A. Sharma and A. Aggarwal (2021). Role of a Miracle tree (*Moringa oleifera*) in healthcare. *J. Evolution Med. Dent. Sci.* 10(21):1628-1632. (Doil:10.14260/jemds/2021/338).

Yoméogo, C.W. M.D. Bengali, A. Savadogo, P.A. Nikiema and S.A. Traore (200). Determination of chemical composition and nutritional values of *Moringa oleifera* leaves. *Pak. J. Nutr*. 10(3):264-268. (doi.org/10.3923/pjn.2011.264-268).

Yongabi K.A. (2010) Bio coagulants for Water and Wastewater Purification: a Review. *International Review of Chemical Engineering* 2:444–458.

Zade, V.S., D.K. Dabadkar, V.G. Thakare and S.R. Pare (2013). Effect of aqueous extract of of *Moringa oleifera* seed on sexual activity of male albino rats. *BFIJS* 5:129-140.

Zaini, B.E., W. Rached, K. Bachari, M.J. Alves, R.C. Cahhelha, L. Barros and I.C. Ferreira (2019). Detailed chemical composition and functional properties of *Ammodaucus leucotrichus* and *Moringa oleifera* Lam. *Functional Foods 53*: 237-247. (doi.org/10.1016/j.jff.2018.12.023).