University of salahadin-Erbil
College of Science
Chemistry Department

Chemical and Biological study of Morgina Oleifera Lam

Prepared by : Gailan Kazm Ali

Supervisor : Jala Bahjat Zewar

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بسم الله الرحمن الرحيم

{وَ قُلْ رَبِّ زِدْنِي عِلْماً}

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Dedication

This study is wholehearted dedicated to our beloved parent, who have been our source of inspiration and gave us strength we thought of giving up, who continually provide their moral, spiritual, emotional and financial support

To our sisters, brother, friends and classmates who shared their words of device and encouragement to finish this study.

Gailan

With love, as always

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1.Introduction

Natural product chemistry can be defined as a branch of chemistry which deals with different organic compounds present in nature, either from plant or animal sources and their extraction separation, characterization, properties reaction beside their utilization. These compounds have significant importance in : chemistry, medicine, pharmacy, industry and agriculture. (L.finar, organic chemistry, vol 1, the function principles, sixth edition, longman group limited, London 1975)

On the other hand the chemistry of natural products which has fostered many of the new developments in these areas, because of the variety of compound types available. (Koji nakanish, natural product chemistry, vol 1, New york and London 1974)

the medical plants are the subject of chemical investigation by pharmacist and the species of the plant used for medical purposed include toxic and non-toxic.(Shork mohammed, medicinal plants, first edition, P36, Baghdad,1986)

the plant also contain special chemical compounds in the tissues, which show certain physiological effect on human body these compounds are : organic acid, mucilage, glycoside, tannins, resins, alkaloids, antibiotics and toxicity.(J.M.King Sbury 19640)

in order to understand the uses of plant and their mode of action it is necessary to know something about their active constituents and the effectiveness of these.(H.fulk 1976)

the vegetable kingdom is an inexhaustible source of new species of plant, which contain active substance, the substance are very useful for curing as scientist in all part of world know this fact,(Shork mohammed 1986).

1.2 The uses of medicinal plants

Modern research have shown that the action of medicinal of plants is due to relatively small number of constituent, called the active principles produced by the plant. (H.fulk 1976)

Drugs are extraction from plants by a method or galenic pharmacy, attributed to the greek physician galentus (131-200AD) and galenus was the first record way of preparation or extraction of natural raw.

Raw drug, dried roots, herbs leaves flowers and fruits are still used for the preparation plant extracted, similarly it has been established in many aces that the medicinal plant has more complete action than the isolated active principle and the ballasts material dose have a roe to play, it is true that for certain uses the active principle or very carefully prepared extracts is more useful than the drug itself, this is because certain constituents which are themselves is active may cause irritation of the tissues at the site of injection or produce a reaction with the blood and these must be avoided at all costs. (H.fulk 1976)

The medicinal action of drugs is at limes under estimated in many cases this is because they have been submitted to incorrect processes of extraction that have partially or entirely destroyed their activity , on the order hand, in popular medicine there is a greater tendency to over-estimated the action of medicinal plant, and properties that cannot by justified by the plants chemicals constituents are attributed to them, on cannot cure tuberculosis, venereal diseases or certain liver complains with medicinal plants, in these cases, they provide only supporting treatment, thus do not expect the impossible from treatments with medicinal plants and above all do not recommend them as such. (H.fulk 1976)

medicinal properties such as such as antitumor, anti-inflammatory, antiulcer, antipyretic, antiepileptic, antispasmodic, antitumor, anti-inflammatory, antiulcer, diuretic, antihypertensive, and antidiabetic. Various M. oleifera reticplant-derived bioactive compounds are shown in Figure 1.

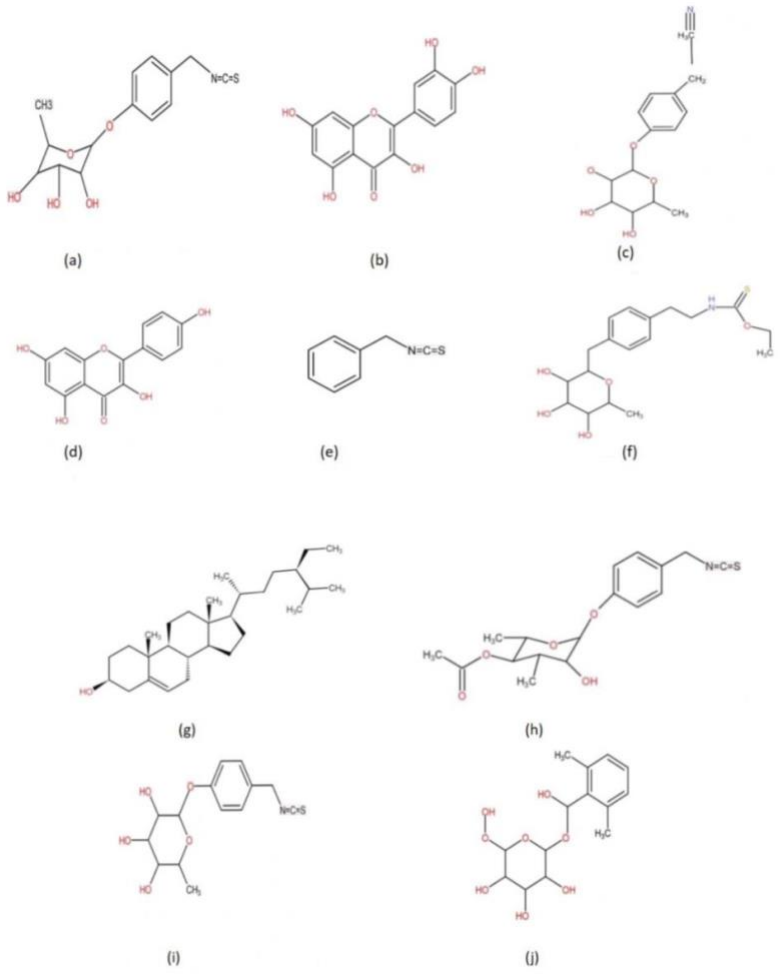
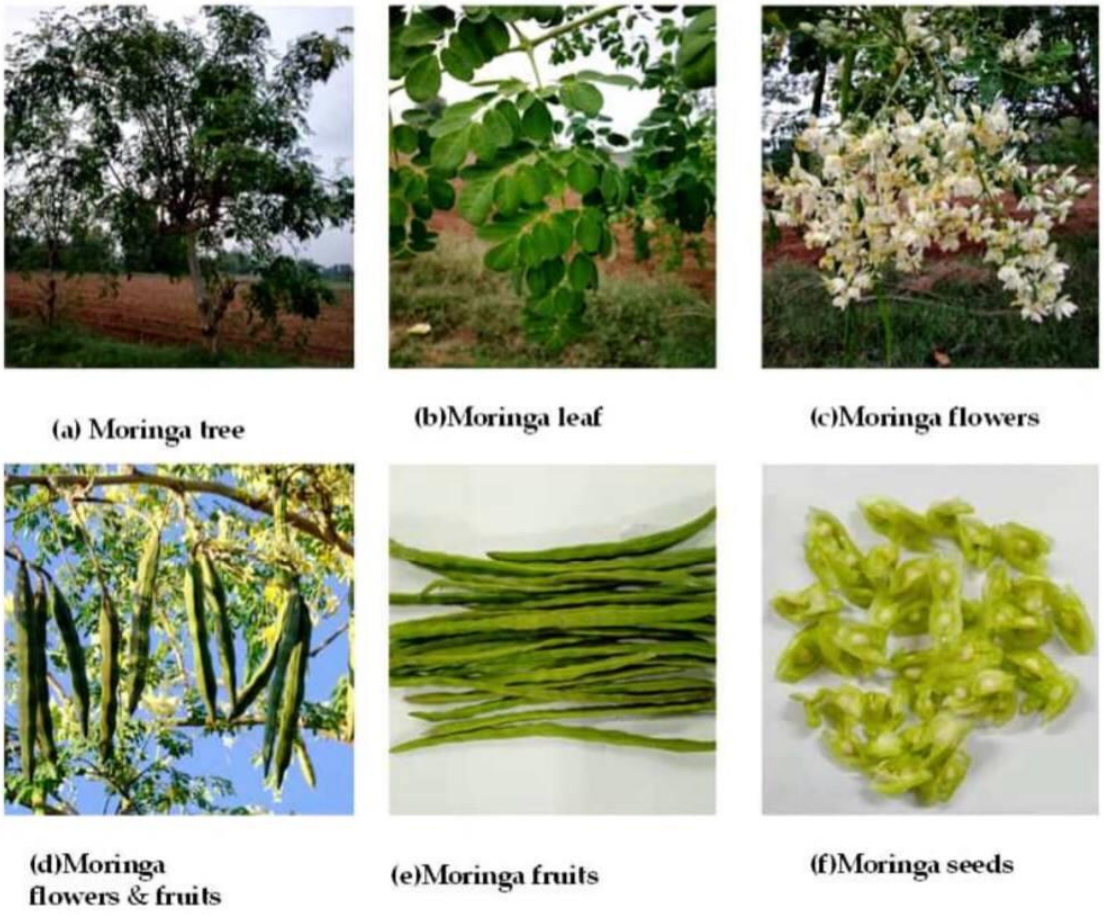


Figure 1. Selected bioactive compounds from Moringa oleifera: (a) 4-(-L-rhamnopyranosyloxy) benzlisothio-benzlisothiocyanate, (b) Quercetin, (c) Niazirin, (d) Kaempferol, (e) Benzyl isothiocyanate, (f) Nia- cyanate (g) β-sitosterol, (h) 4-(4-O-acetyl-a-L-rhamnosyloxy) benzyl isothiocyanate, (i) 4-(α-l-rhamnopyranosyloxy) benzylisothiocyanate, (j) Moringine. cyanate,.



Figure(2): Moringa oleifera

2. Description

2.1 Taxonomical features of the moringa oleifera tree:

Moringa oleifera is small growing evergreen or deciduous tree that usually grows up to 10-12 m in height(Sunidhi Mishra et al 2020)

Diameter – 45 cm (1.5 ft). Colour – Bark – whitish grey Young shoots – purplish (or) greenish white .Flowers – Fragrant, bisexual and surrounded by five unequal, thinly viened, yellowish white petals. Flowers are about 1.0-1.5 cm (long) and 2.0 cm (broad). Fruits – They have hanging type of fruits , globular seeds of about 1 cm in diameter , capsule is three sided brown in colour of size 20 – 45 cm .Seeds have three whitish papery wings . Propagation is usually by wind and water(R.Ramasubramania Raja et al 2016)

2.2 name of Moringa Oleifera tree:

Moringa tree has been called as ‘miracle tree’ with justification. The leaves, fruit, sap, oil, roots, bark, seeds, pod and flowers of the tree have medicinal values. The preparations from the tree have numerous uses. It is also known as the ‘drumstick tree’. It is available in India, the Sudan, southern Africa, the Pacific and Caribbean Islands and South America(Dibya Sundar Panda 2021)

3. General use of Moringa Oleifera:

Moringa oleifera has been used as a medicine in India since the 18th century BC. Traditional healers used different parts of the plant as traditional medicines. The medicinal uses are numerous and have long been recognised as an Ayurvedic and Unani system of medicine. Almost all parts of the plant: root, bark, gum, leaf, fruit (pods), flowers, seeds and seed oil, have been used to treat various diseases, like skin infections, swelling, anaemia, asthma, bronchitis, diarrhoea, headache, joint pain, rheumatism, gout, diarrhoea, heart problems, fevers, digestive disorders, wounds, diabetes, conjunctivitis, haemorrhoids, goitre, earache, measles and smallpox in the indigenous system of medicine (Paula García Milla et al 2021)

Moringa oleifera leaves, pods and seeds contains a high concentration of many powerful ingredients that are of health benefits. It is the most nutrient rich plant ever revealed. Many experts feel that Moringa oleifera claims the comprehensive collection of vital nutrients of any botanical plant known on the earth. It has anti-oxidants, antiinflammatory, anti-bacterials, vitamins, minerals, 20 amino-acids (including the 9 essential aminoacids that the body cannot produce), enzymes, essential fatty acids, carbohydrates, anti-aging elements, chlorophylls and other phyto-chemicals and nutrients all in one that are fully adapted and absorbed by the human. Nourishes the Body's Immune System. Moringa oleifera provides many dozens of nutrients that strengthen your body's immune system promotes healthy circulation. Scientific research demonstrates that Moringa oleifera is rich in enzymes. Recent research, consisting of many highly reputable medical, science, and globally recognized health institutions, advises that Moringa oleifera has plentiful therapeutic properties that provides natural anti-aging benefits. (Dibya Sundar Panda 2021).

Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300–400 mg, moringa leaves can provide 1000 mg and moringa powder can provide more than 4000 mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while moringa leaf powder has 28 mg of iron. It has been reported that moringa contains more iron than spinach. (Lakshmipriya Gopalakrishnan et al 2016).

Moringa oleifera is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan; it is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia

3.1 Benefits/Uses of MO Plant

Numerous Research study shown the many uses/benefits of MO tree in various fields such as useful in Pharmaceutical, useful for making food, water purification, useful as a pesticide for crop field.Some other benefits of MO includes useful as a cleaning agent, production of Biofuel and the some research study also report the use of parts of Drumstick Tree detailed discussed in below(Daba H Mekonnen 2016).

3.2 Medicinal use of parts of Moringa Oleifera

All parts of the drumstick Plant are useful for Many preparation like pharmaceutical preparation, food preparations, neutraceuticals and also useful for production of biodiesel and water purification. They contain a rich source of Vitamins, Minerals, Protein and some other phenolic compounds etc. whole parts of plant are used such as Leaves, stem, Fruit, Seeds, Pod, Root discussed in below:-

Table 1: Phytochemicals and their medical uses of Moringa oleifera

Plant Parts	Phytochemicals Present	Medicinal Uses
Seed	Ben oil, Thiocarbamate and isothiocyanate	Ben oil has the ability to show resistance against oxidative degradation. Seed powder of *M. oleifera* Ben oil can also provide a defense to the oxidative stress induced by the arsenic and prevent the accumulation of arsenic in the tissues and blood. Various compounds related to thiocarbamate and isothiocynate exhibit antitumor potential by inhibiting the tumor promoter teleocidin B-4-induced Epstein–barr virus.
Flower	Flavanoid-quercetin	*M. oleifera* flowers possess a flavanoid known as quercetin which have a significant impact on regulation of liver function due to its heatoprotective effects.
Gum	Gum exudates	These gum exudates are non-toxic compounds that improve stability of therapeutics thereby overall efficiency of the therapeutics. These are also used to treat various chronic disorders.
Leave	Flavanoids, Carotenoids, phenols, vitamin A	Antioxidant activity of *M. oleifera* leaves is mostly due to the presence of flavanoids. Carotenoids are naturally occurring pigments of plant that help in the prevention of damage to photosynthetic apparatus by excessive light intensity. Carotenoids also function as antioxidants along with working as protecting agent for aging, cellular damage and provide many health benefits. Higher concentration of phenols in leaf extract can induce caspases thereby resulting in cellular apoptosis. Vitamin A present in *M. oleifera* leaves regulates various functions such as vision, growth and reproduction, immune system cellular growth and apoptosis and brain activities.
Pod	Methyl phydroxybenzoate and β-sitosterol	*M. oleifera* pod contains Methyl phydroxybenzoate and β-sitosterol that play a very efficient role in the lowering of blood pressure.
Root bark	N-benzyl, S-ethyl thioformate	N-benzyl, S-ethyl thioformate isolated from bark of *M. oleifera* root. This compound showed antimicrobial activity.
Root	Pterygospermin, 4-α-L-rhamnosyloxy benzyl isothiocyanate	*M. oleifera* roots contain Pterygospermin, and 4-α-L-rhamnosyloxy benzyl isothiocyanate components that show a very significant antimicrobial activities. These components play a very important role in antifungal and antimicrobial activities of *M. oleifera* roots.

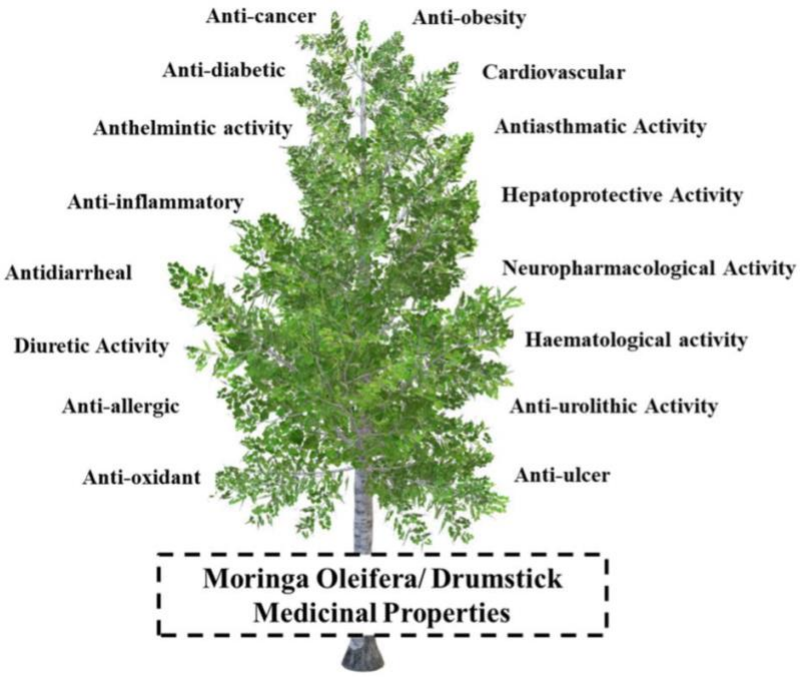


Figure 3: moringa oleifera medicinal properties

3.3 Medicinal Properties and Biomedical Applications

M. oleifera has a variety of activities, including the ones to be used as a galactagogue, rubefacient, antiscorbutic, diuretic, stimulant, purgative, antimicrobial, antibacterial, anti-inflammatory, antitumor, antioxidant, anti-aging agent, hypoglycaemic, antipoetryroidism, anti-cellular (Nadkarni 1996). (Gilani 1997).

3.3.1 Analgesic, Anti-Inflammatory, and Antipyretic Activities

All aspects of this marvel tree have been found to show pain-relieving mechanisms like that of indomethacin in various animal models. Extracts from leaves, seeds, and bark showed significant pain-relieving action in both focal (hot plate technique) and fringe models (acid-induced squirming strategy),

in a dose-dependent manner. The practical application demonstrated viability against neuropathic pain caused by multiple sclerosis.(Chirag Prajapati et al 2022).

3.3.2 Neuropharmacological Activity

Aqueous extract of M. oleifera leaves has been seen as assurance against Alzheimer's disease in a colchicine-instigated Alzheimer's disease model utilizing social testing . Protected Alzheimer's disease can be fought by controlling electrical activity and monoamine levels in the brain. Another study looked at the toluene-ethyl acetic acid derivation component of the methanolic concentrate of leaf and found that it had intense nootropic action. The vitamins C and E found in the extracted leaf of M. oleifera play a crucial part in memory formation in Alzheimer's disease patients. Anticonvulsant action of leaf was demonstrated in male albino mice utilizing pentylenetetrazole and maximal electric shock paradigms. Penicillin-induced epileptic convulsions were reduced in adult albino rats by aqueous extract of the root (Mohan, M. Kaul et al 2005) (Akram 2017)

3.3.3 Anticancerous Activity

In mouse melanoma tumor model tests, alcoholic and hydromethanolic extracts of leaves and fruits exhibited a considerable growth delay in tumor kinetics. M. oleifera leaf extract has antiproliferative action against A549 lung cancer cell line, The exposure of leaf extract into chick chorioallantoic membrane leads to antiangiogenic action that was in accordance with dose-dependent manner, demonstrating their strong anticancer potential .(Chirag Prajapati et al 2022).

3.3.4 Antioxidant Activity

M. oleifera foods offer significant antioxidant properties against a variety of free radicals. Prepared leaf extract showed a considerable decrease in malondialdehyde levels and a significant increase in glutathione levels In vivo studies. Several extracts prepared from natural sources showed useful in scavenging of free radicals activity of roots altogether decreased iron and FeSO4-activated microsomal lipid peroxidation in a part subordinate way. Antioxidant activity of pods through the 2-diphenyl-2-picryl hydroxyl (DPPH) method has been reported by researchers. In a male BALB/c rat model of acetaminophen-induced nephrotoxicity, M. oleifera leaf extract demonstrated a nephroprotective effect in addition to antiproliferative effect. (Chirag Prajapati et al 2022).

3.3.5 Hepato protective Activity

An extract of the moringa leaves had hepatoprotective effects in Sprague Dawley rats. They had been made aware of carbon tetrachloride or acetaminopheninduced liver toxicity. Furthermore, hepatoprotection against antitubercular medicines and liver damage caused due to alloxan treatment. The M. oleifera plantbased daily therapy for the period of 21 days was demonstrated to have huge potential in constricting hepatic injury. Ascorbic acid, quercetin, kaempferol, and benzyl glucosinolate have all been discovered with hepatoprotective properties (Chirag Prajapati et al 2022).

3.3.6 Anti-Ulcer and Gastro protective Properties

The extract of leaves significantly reduced ulcer biomass in a gastric ulcer model caused by ibuprofen and a pyloric ligation test and in addition to a considerable decrease in duodenal ulcers and stress ulcers caused by cysteamine. This property could be enhanced by flavonoids and biphenyls (Gilani et al 1994)

3.3.7 Cardiovascular Activity

In male Wistar rats, an extract of M. oleifera leaf reduced cholesterol levels and acted as a defense against hyperlipidemia caused by iron deficiency. In lower chronotropic and inotropic effects in damaged frog hearts, leaf extract had an antihypertensive effect on diseased hypertensive rodents . Nazanin B, niazinin A, and miasmic are active ingredients for hypotensive activity. In Male Wistar rats model, Is proterenol induced myocardial infarction was also inhibited by a leaf extract. The component responsible for this cardio protective action was cell proliferation, lipid peroxidation prevention, and protection against isoproterenol-induced ultrastructure and histopathology unsettling effect. (Chirag Prajapati et al 2022).

3.3.8 Antiobesity Activity

There was a considerable weight loss as compared to the fat control grouped by using oral therapy with leaf powder extract of M. oleifera. Treatment of hypercholesterolemia animals with methanolic M. oleifera leaf extract for 49 days resulted in a major reduction in cholesterol level, body weight, fatty acids, as well as blood glucose level, liver indicators, and organ weight levels. In heavy rats, downregulation of leptin and resistant mRNA articulation and overexpression of

adiponectin quality articulation are among the mechanisms (Mahajan and S.G.Mehta 2008).

3.3.9 Antiasthmatic Activity

Extract of seeds showed assurance significant efficacy against asthma as researched in different models; an immediate bronchodilator effect was hypothesized for this effect, together with moderating and antibacterial actions and prudence of prompt, easily affected reaction. In bronchoalveolar lavage, an ethanolic extract of seeds showed potent efficacy against ovalbumin-induced bronchoalveolar lavage, guinea pigs showed a significant expansion of respiratory boundaries and a decrease in interleukin release (Archibong et al 2017)

3.3.10 Hematological Activity

A randomized, double-blind, placebo-controlled trial was conducted on ladies who were pallid with hemoglobin levels somewhere in the mean hemoglobin, and mean corpuscular hemoglobin concentrations increased after being treated with an aqueous extract of moringa leaf in the 8–12 g/dL range. Another review uncovered the potential of moringa for healthy human volunteers for 14 days aiding in a significant increase in platelet count (Chirag Prajapati et al 2022).

3.3.11 Antidiabetic Activity

In normal and abnormal circumstances alloxan-induced or cysteamine-induced duodenal and peptic ulcers, the leaf extract had a significant antihyperglycemic and hypoglycemic effect. With type 1 diabetic mouse models, an extensive review was conducted to determine the impact of the elimination of lipid profile, glucose, oral glucose resilience, body weight, and plasma insulin (Chirag Prajapati et al 2022).

3.3.12 Anti-Urolithic Activity

In a hyperoxaluria-induced mouse model and ethylene glycol-induced urolithiasis model, aqueous and ethanolic extract of this plant showed anti-urolithiatic activity (Medhi et al 2003).

3.3.13 Diuretic Activity

Seeds, roots, leaves, flowers, and bark extract expanded urine yield in rodents; extract of leaf showed a portion subordinate diuretic activity more prominent than control yet not as much as hydrochlorothiazide. This activity was attributed due to the presence of campesterol, stigmasterol, β-sitosterol, and avenasterol (Monera et al 2008).

3.3.14 Anti-Allergic Activity

Ethanolic extract of seeds hindered latent cutaneous hypersensitivity incited by hostile to Immunoglobulin G (IgG) and histamine release from pole cells; the mechanism is hidden, yet its activity could be harmful in layer settling action and more decreased scratching recurrence in an ovalbumin refinement model (Cabeza et al 2011).

3.3.15 Anthelmintic Activity

It took a very less effort to incapacitate Indians because the plant had great anthelmintic activity. Ethanolic extract and aqueous extract, separately and in larvicidal measure, showed 95.89 percent and 81.72 percent egg incubates hindrance, respectively, in ovicidal examination. They were deemed adequate for 56.94 percent of the time and 92.50 percent of the time (Namasivayam et al 2011).

3.3.16 Antidiarrheal Activity

In male Wister rats, extract of moringa seeds demonstrated a considerable decrease in gastrointestinal motility and were considered viable in castor oil mediated loose bowels. Tannins, saponins, and flavonoids are phytochemical compounds that have antidiarrheal properties (Cabardo et al 2017).

4. phytochemistry

Phytochemicals are, in the strictest sense of the word, chemicals produced by plants. Commonly, though, the word refers to only those chemicals which may have an impact on health, or on flavor, texture, smell, or color of the plants, but are not required by humans as essential nutrients. An examination of the phytochemicals of Moringa species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates (10,38). For example, specific components of Moringa preparations that have been reported to have hypotensive, anticancer, and antibacterial activity include 4- (4'-O-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocyanate [1], 4-(α-L-rhamnopyranosyloxy)benzyl isothiocyanate [2], niazimicin [3], pterygospermin [4], benzyl isothiocyanate [5], and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate [6]. While these compounds are relatively unique to the Moringa family, it is also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin and will be the subject of a future review in this series.(Jed Fahey 2005)

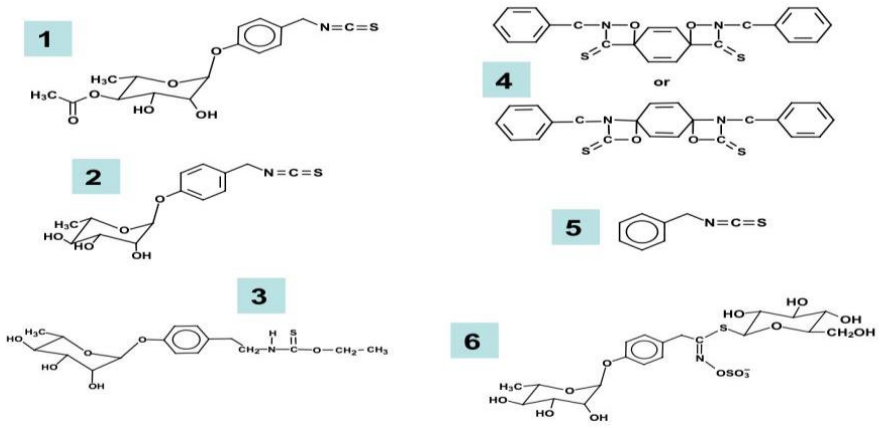


Figure 4. Structures of selected phytochemicals from Moringa.: 4-(4'-O-acetyl-α-Lrhamnopyranosyloxy)benzyl isothiocyanate [1], 4-(-L-rhamnopyranosyloxy)benzyl isothiocyanate [2], niazimicin [3], pterygospermin [4], benzyl isothiocyanate [5], and 4-(α-L-rhamnopyranosyloxy)benzyl glucosinolate [6]

5. Moringa Oil

is the oil expressed from the seeds of Moringa oleifera, Moringaceae, native plant species of a native of the western and sub-Himalayan tracts, India, Pakistan, Asia Minor, Africa, and Arabia and distributed in The Philippines, Cambodia, Central America, North and South America, and the Caribbean Islands.

Moringa seeds are considered to be antipyretic, acrid, and bitter. They are reported to show antimicrobial activity and interest in the composition of M. oleifera seeds, and the extracted moringa oil, also known as “Ben” or “Behen”, oil has existed over the years. A very low value of FFA as determined for MORINGA OIL, indicative of good quality, also exhibiting a very good oxidative state. moringa oil contains a high level of monounsaturated fatty acids, being oleic the predominant fatty acid, which accounted for 65-85% of the total.

This fatty acid composition shows that it falls in the category of high-oleic oils and contains a high ratio of monounsaturated to saturated fatty acids. High-oleic oils, although genetically hard to reproduce, are growingly pursued because of their superior stability and nutritional benefits. (Anwar, F. and Bhanger 2003)

5.1 Technical data

Parameter	Value
Acid value (mg KOH/g)	Max. 6
Peroxide value (meq/Kg)	Max. 10.0
Behenic acid	3.0 – 10.0%
Oleic acid	65-85%

5.2 Application of moringa oil

Moringa Oil may be directly applied on skin and hair. It may also be easily incorporated as an active ingredient or an excellent carrier in skin and hair care products. Its recommended dosage is between 3 to 10%. Moringa Oil contains behenic fatty acid, useful as a thickening agent and surfactant. Behenic acid, also called docosanoic acid, is a long-chain saturated fatty acid used in the cosmetic and hair care industry, manufacture soaps and other cosmetic and hair care products. Behenic acid has conditioning properties that help to keep skin and hair soft and smooth, being commonly added to facial moisturizers and hair conditioners to make skin look moist and feel smoother and hair easier to manage. (Anwar, F. and Bhanger 2003)

5.3 Physical and chemical of Moringa oil

Moringa oleifera Oil			
Characteristics	**Cold Press [a]**	***n*-Hexane [b]**	**Overall**
density at 24 °C (mg/mL)	0.901 ± 0.002 (0.899–0.904)	0.901 ± 0.011 (0.881–0.920)	0.901 ± 0.009 (0.881–0.920)
refractive index (40 °C)	1.462 ± 0.005 (1.459–1.470)	1.459 ± 0.004 (1.455–1.470)	1.460 ± 0.005 (1.455–1.470)
color red units	1.7 ± 0.5 (1.0–2.0)	1.1 ± 0.6 (ND–2.2)	1.3 ± 0.6 (ND–2.2)
color yellow units	28.3 ± 2.4 (25.0–30.0)	35.8 ± 14.0 (22.3–70.0)	33.5 ± 12.0 (22.3–70.0)
smoke point (°C)	203 ± 2 (201–204)	200 ± 1 (198–202)	201 ± 2 (198–204)
viscosity (mPa × s)	79.5 ± 25.6 (43.8–103.0)	52.8 ± 8.1 (43.6–62.0)	64.7 ± 21.8 (43.6–103.0)
acidity (% as oleic acid)	1.91 ± 1.13 (1.01–3.50)	1.07 ± 1.12 (0.32–4.00)	1.33 ± 1.15 (0.32–4.00)
saponification value (mg of KOH/g oil)	189.6 ± 8.0 (179.8–199.3)	183.7 ± 4.3 (178.1–191.2)	185.5 ± 6.0 (178.1–199.3)
iodine value (g of I/100 g of oil)	66.54 ± 0.97 (65.73–67.80)	67.86 ± 1.45 (65.58–69.45)	67.46 ± 1.43 (65.58–69.45)

Table (2)

6. Moringa oleifera Seeds and Oil: Characteristics and Uses for Human Health

6.1 Chemical Characteristics of Seeds and Oil

M. oleifera seeds are globular, about 1 cm in diameter. They are three-angled, with an average weight of about 0.3 g, 3-winged with wings produced at the base of the seed to the apex 2–2.5 cm long, 0.4–0.7 cm wide; the kernel is responsible for 70%–75% of the weigh.

A multipurpose Indian vegetable. Oil is the main component of the seed and represents 36.7% of the seed weight. The oil can be extracted almost entirely by solvent extraction, generally n-hexane, whereas less yield is obtained by cold press extraction. In fact, only 69% (on average) of the total oil contained in seeds can be extracted by cold press. Among rural dwellers, the edible oil is extracted by boiling de-husked seeds with water,

and collecting the oil from the surface of the water. Apart from the oil, the seed has a high protein content, on average 31.4%, whereas carbohydrate, fibre and ash contents are 18.4%, 7.3% and 6.2%, respectively. Thus, the defatted seeds of M. oleifera could provide an economical source of protein for use as a food supplement to traditional diets to increase protein intake. Furthermore, like the protein fraction, M. oleifera seeds have a high content of methionine and cysteine, close to that reported for milk and eggs. Therefore, they can be consumed together with legumes which are deficient in sulphur amino acids. Moreover, M. oleifera seeds seem to be free of trypsin inhibitor and urease activity, confirming the high protein digestibility (93%) of M. oleifera seeds. Table 3 shows the chemical composition of the M. oleifera seed.(Oliveira, J.T.A et al 1999)

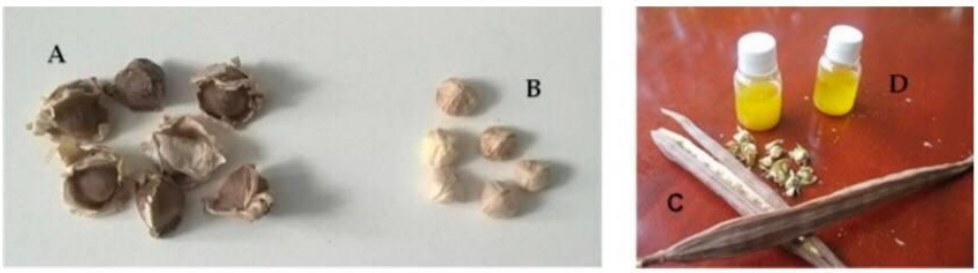


Figure 5. Seeds (A), kernels (B), fruits (C) and oil (D) of Moringa oleifera

Nutrients	*Moringa oleifera* Seeds		
	Mean	SD	Range
Fat	36.7	2.8	(34.7–40.4)
Proteins	31.4	1.3	(29.4–33.3)
Carbohydrates	18.4	1.4	(16.5–19.8)
Fiber	7.3	0.5	(6.8–8.0)
Ash	6.2	0.9	(4.4–6.9)
Moisture	7.0	1.2	(5.7–8.9)

Table 3. Chemical composition of Moringa oleifera seeds (g/100 g of dry weight).

6.2 Fatty acid composition, degree saturation and degree unsaturation of M. oleifera seed oil

The high degree of unsaturation (75.2%) of the oil is due to the high percentage of oleic acid (70%) (Abdulkarim et al., 2005). Apart from oleic acid, other prominent fatty acids include palmitic (7.8%), stearic (7.6%) and behenic (6.2%) acids (Table 1). Anwar and Bhanger (2003) in their study on M. oleifera grown in temperate regions reported that the oleic acid content tended to be higher (up to 78.5%) compared to plants grown in the tropics. (Hasanah Mohd Ghazali and Abdulkarim Mohammed 2001)

Type of fatty acid	Percent
Myristic/Tetradecanoic acid (C14:0)	0.2
Palmitic/Hexadecanoic acid (C16:0)	6.8
Palmitoleic/Hexadecenoic acid (C16:1)	2.9
Stearic/Octadecanoic acid (C18:0)	6.5
Oleic/Octadecenoic acid (C18:1)	70.0
Linoleic/Octadecadienoic acid (C18:2)	0.9
Linolenic/Octadecatrienoic acid (C18:3)	-
Arachidic/Eicosanoic acid (C20:0)	4.2
Gadoleic/Eicosaenoic acid (C20:1)	1.4
Behenic/Docosanoic acid (C22:0)	5.8
Arachidic/Eicosanoic acid (C24:0)	1.3
Unsaturated fatty acid	50.9
Saturated fatty acid	49.1

Table (4)

6.3 Bioactive compounds in M. oleifera seeds.

In addition to their macronutrient composition (Table 5), making them attractive for oil production and as an economic source of protein, the seeds of M. oleifera have been extensively studied for their content in secondary metabolites, also making them interesting for medical purposes. Several studies have found good antioxidant activity and have isolated phytochemical compounds that, because of their biological properties, can be used as nutraceutical molecules. The total phenolic content of M. oleifera seeds has been found to be in the range of 4581–4953 mg/100 g, similar to leaf amounts. The flavonoids are represented by catechin, epicatechin, quercetin and kaempferol, present mainly in the bound form. Moreover, several phenolic acids have been identified, gallic acid predominating, followed by ellagic and caffeic acids. Phenolic acids, like p-coumaric, vanillic, protocatechuic, ferulic and cinnamic acids, have also been identified in M. oleifera seeds, but in smaller amounts. Interestingly, M. oleifera seed also contains important bioactive compounds including alkaloids, glucosinolates, isothiocyanates and thiocarbamates.(Singh, B.N et al 2009,)(Guevara, A.P et al1999,) table (5)

Compounds	Compounds
Alkaloids	**Glycosides**
Moringine	Strophantidin
	4-(α-L-rhamnosyloxy)benzyl isothiocyanate
Flavonoids	4-(4′-*O*-acetyl-α-L-rhamnosyloxy)benzyl isothioyanate
Catechin	4-(β-D-glucopyranosyl-1→4-α-L-rhamnopyranosyloxy) benzyl thiocarboxamide
Epicatechin	4-*O*-(α-L-rhamnosyloxy)benzyl glucosinolate
Quercetin	4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate
Kaempferol	Niazimicin
	4-(α-L-rhamnosyloxy)benzyl acetonitrile (niazirin)
Phenolic acids	*O*-ethyl-4-(α-L-rhamnosyloxy)benzyl carmate
Gallic acid	Glycerol-1-1-(9-octadecanoate)
p-Coumaric acid	3-*O*-(6′-*O*-oleoyl-β-D-glucopyranosyl)-β-sitosterol
Ferulic acid	β-sitosterol-3-*O*-β-D-glucopyranoside
Caffeic acid	3-Hydroxy-4-(α-L-rhamnopyranosyloxy)benzyl glucosinolate
Protocatechuic acid	4-(2/3/4′-*O*-acetyl-α-L-rhamnopyranosyloxy)benzyl glucosinolate
Cinnamic acid	Glucosinalbin
Ellagic acid	Glucoraphanin
	Glucoiberin

6.4 chemical composition of moringa oil

Component	Ri [a]	Ri [b]	Identification [c]	%
Oxygenated monoterpenes				
Linalool	1099	1553	1,2,3	t
α-Terpineol	1189	1706	1,2,3	t
Phenolic compounds				
p-Vinylguaiacol	1311	1937	1,2	t
Oxygenated sesquiterpenes				0.7
cis-Dihydroagarofuran	1518		1,2	0.1
Eudesm-11-en-4-α,6α-diol	1807		1,2	0.6
Hydrocarbons				91.1
1-Octadecene	1783		1,2	0.3
Octadecane	1800		1,2,3	0.1
5-Octadecin	1844		1,2	0.3
n-Hexadecanol	1889		1,2	0.1
Nonadecane	1896		1,2,3	0.8
1-Eicosene	1990		1,2	0.3
Eicosane	1998		1,2,3	1.2
n-Octadecanol	2091		1,2	0.2
Heneicosane	2100		1,2,3	1.9
Cyclopentadecanol	2119		1,2	0.4
1-Docosene	2191		1,2	0.4
Docosane	2200		1,2,3	6.8
cis-9-Eicosen-1-ol	2224		1,2	0.3
Tricosane	2297		1,2,3	8.1
Tetracosane	2405	2400	1,2,3	9.7
Pentacosane	2499	2500	1,2,3	13.3
Hexacosane	2601	2600	1,2,3	13.9
Heptacosane	2698	2700	1,2,3	11.4
Octacosane	2821	2800	1,2,3	10.0
Nonacosane	2930	2900	1,2,3	10.5
Triacontane	3008	3000	1,2,3	1.1
Others				0.5
Hexenyl propanoate	1101		1,2	t
Phenylethyl alcohol	1110		1,2	t
Pseudo Phytol	2016		1,2	0.5
Total identified				92.3

Table (6)

(a)Kovats retention index on HP-5 MS column;(b) Kovats retention index on HP Innowax; (c) 1 = Kovats retention index, 2 = mass spectrum, 3 = co-injection with authentic compound; t = trace, less than 0.1% (Tatiana Marrufo et al 2013)

7. Chemical Constituents of Moringa oleifera Lam

Moringa oleifera Lam. locally known as malunggayhas been used to combat malnutrition, specially among infants and nursing mothers. The leaves are used for the treatment of malaria, typhoid fever, parasitic diseases, genito-urinary ailments, hypertension, arthritis, swellings, cuts, diseases of the skin, and diabetes as well as cardiac stimulants, contraceptive remedy, elicit lactation and to boost the immune system.

Investigation of the carotenoid contents from the leaves, flowers and fruits of eight M. oleifera cultivars from India yielded luteoxanthin, lutein, zeaxanthin, and β-carotene. Lutein was identified as the major constituent of the leaves and fruits accounting for 53.6 and 52.0 % of the total carotenoids, respectively. Furthermore, the β-sitosterol, total phenolic and flavonoid compounds in the leaves of M. oleifera were reported as 90 mg/g, 8 μg/mL and 27 μg/mL, respectively. The leaves of M. oleifera were also reported to contain chlorophyll a, chlorophyll b, vitamin C, carotenoids, proteins, amino acids and minerals. We earlier reported the isolation of polyprenol, phytyl fatty acid esters and lutein from the leaves of M. oleifera. A review on the cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of M. oleifera leaves has been provided.

We report herein the isolation of lutein (1), β-carotene (2), phytyl fatty acid ester (3), polyprenol (4), chlorophyll a (5), β-sitosterol (6), triacylglycerols (7) (Fig. 1), fatty acids, fatty alcohols, and saturated hydrocarbons from the leaves of M. oleifera.

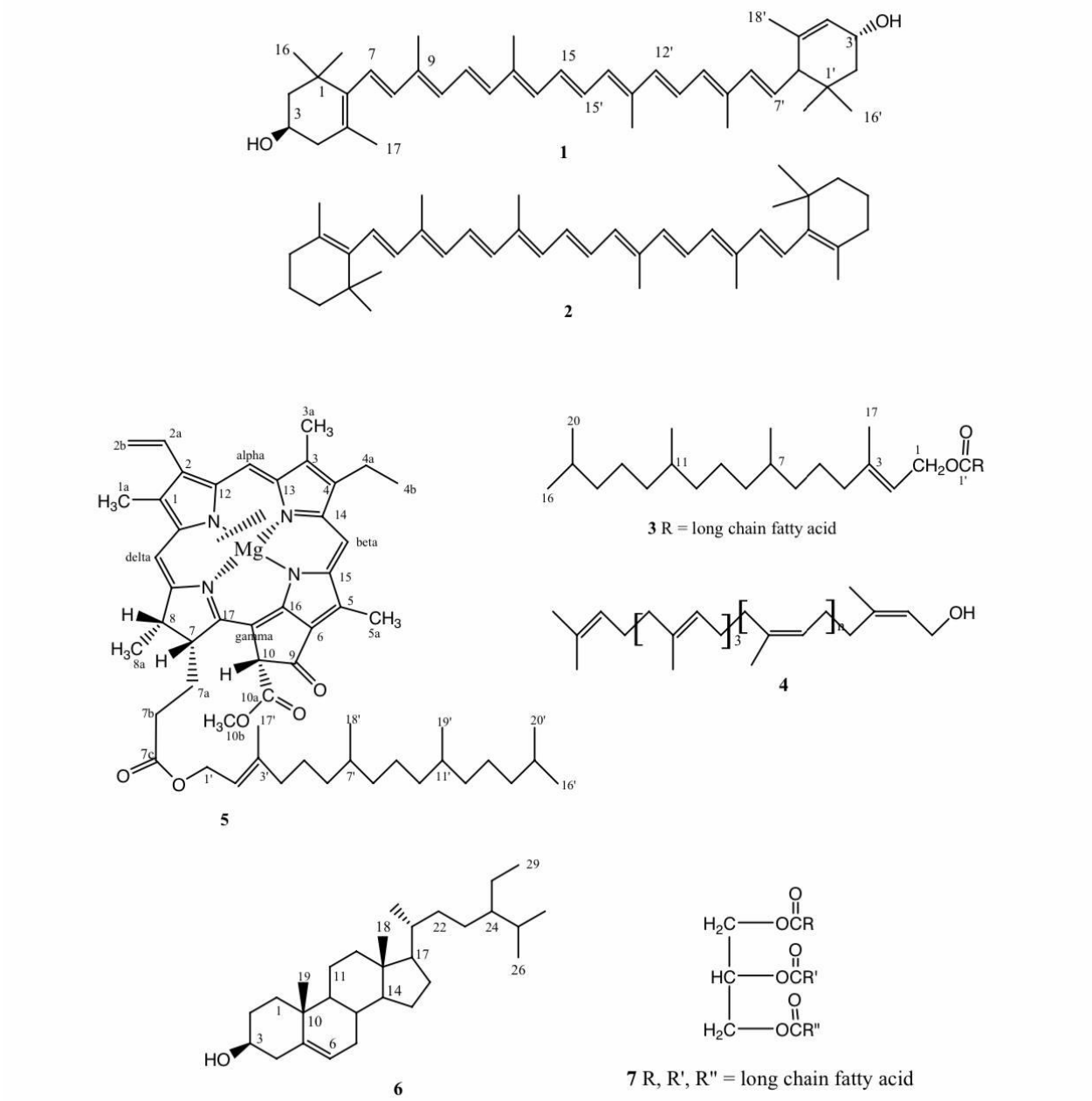


Figure 6: Chemical structures of lutein (1), β-carotene (2), phytyl fatty acid ester (3), polyprenol (4), chlorophyll a (5), β-sitosterol (6), triacylglycerols (7) from the leaves of M. oleifera Lam.

7.1 Properties of moringa oleifera component

Lutein has been reported for many useful biological activities and therapeutic potentials and the underlying molecular mechanism of actions to the associated activities have been identified. (mahendran sekar 2020)

β-Carotene belongs to a group of more than 600 compounds, jointly called as carotenoids. It has numerous biological functions in the human body and because human is not able to synthesize any of them, it is necessary to supply these valuable compounds with food or pharmaceuticals. (Joanna harasym and ludmila urszula bogacz-radomska 2018)

Polyprenols are a well-known class of natural substances that have mostly been studied for their anti-inflammatory, hepatoprotective, and immunomodulating functions. Recently, polyprenols were also tested in muscle strength and coordination experiments in combination with widely used drugs statins, reducing their side effects in vivo and in patients. Polyprenols are hydrophobic molecules of natural long-chain isoprenoid alcohols.

Sterols are naturally occurring alcohols with a steroid structure (a tetracyclic structure with two angular methyl groups), which varies in the number of cyclic double bonds. An alkyl side chain, which also may have double bonds, is attached to the ring system. Plant sterols, also known as phytosterols, include over 100 different sterols in various plant species. Phytosterols are secondary plant metabolites that serve important biological functions in cell membranes, such as stabilizing the phospholipid bilayers, regulating the fluidity of mem- branes, and inducing the membranes to adapt to temperature alterations. (maria katsouli 2021)

7.2 Isolation and synthesis

isolation of lutein from Indian spinach, Basella alba was carried out. For the extraction of lutein, petroleum ether- acetone extract of spinach leaves was prepared which yielded 2.3 mg/100g of lutein. Preparative TLC of the extract yielded lutein with a Rf value of 0.12. Lutein isolated was subjected to spectral characterization by UV-Visible and FT-IR spectroscopy. (Ashwini prabhu 2015)

The initial step in the synthesis of pure b-sitosterol is the preparation of the stigmasterol tosylate 8 from the readily available stigmasterol 1 (95% purity) using standard tosylation conditions. The tosylate was then treated with anhydrous MeOH and pyridine in a solvolysis to give i-stigmasterol methyl ether 9 as an oily solid in 74% yield, as a mixture with stigmasterol methyl ether 10 in a ratio of 5 : 1. This minor product has not been previously identified as a side product from this reaction. The mixture can be separated after repeated chromatography, however the material was used unpurified and the minor product removed by chromatography in the subsequent step. (Florence O Mccarthy 2015).

8. Conclusion

Drumstick plant is a tropical tree with a diverse range of applications and is attracting increasing international attention for exploring more therapeutic interventions. It should be broadly developed in the great majority of places where climatic conditions are difficult to predict for its ideal development. Various studies on M. oleifera have been conducted so far, This plant has been shown to be effective in preclinical studies and found to have pain-relieving, calming, anthelmintic, anticancer, local sedative, nootropic, hepatoprotective, gastroprotective, anti-hypersensitivity, anti-ulcer, cancer preventive, asthmatic, diuretic, cardiovascular, anti-stoutness, antidiabetic, antiepileptic, anti-urolithiasis, injury-repairing potentialitie. Natural Phytochemical have major contributed to discovery and development of new chemical entities with pharmacological active potential against various diseases. It is most of the M.olifera had exhibited in various activites. The Phytochemical constituents are pharmacological active studies support its traditional uses and should convince be useful for clinical evaluation and development of economic drugs. M. oleifera seeds and oil are intriguing products due to their nutritional constituents and bioactive components materials. Moringa plant being a rich source of phytoconstituents, have the prospects to develop functional food and nutraceuticals. However, detailed in vitro and in vivo evaluations of bioavailability and biological activities are compulsory to permit reasonable and appropriate recommendations of phytoconstituents for future drug development. Therefore, Moringa oleifera can be safely used as a food supplement (Moringa oleifera capsules), or as part of a healthy balanced diet (for example, Moringa oleifera tea). It might be useful as complementary therapy for the prevention and treatment of cardiovascular diseases, obesity, atherosclerosis,

metabolic syndrome and diabetes type II.

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