

***Moringa oleifera*: A review on its nutritional importance, natural properties, and chemical characteristics.**

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Abstract

Moringa oleifera, also known as the drumstick tree, is widely cultivated in tropical and subtropical regions. It is one of the most commonly used plants worldwide, as almost all parts of this tree are utilized in medical and commercial fields. Its leaves contain various vitamins and minerals and serve as a good source of protein and amino acids. *Moringa oleifera* exhibits important medicinal properties, including anticancer, antidiabetic, and antimicrobial effects. Additionally, this plant has shown potential in lowering blood pressure, cholesterol levels, and body weight while improving liver and kidney functions and enhancing male fertility. Due to its high antioxidant content, *Moringa oleifera* is also used as a natural preservative in the food industry. This review explores the chemical composition, medical applications, and cultivation conditions of *Moringa oleifera*, along with its potential toxicity and role in disease management. It also highlights its commercial applications.

Keywords; *Moringa oleifera*, nutritional value, bioactive compounds, antioxidants, phytochemicals, medicinal properties, therapeutic applications, chemical composition.

1. INTRODUCTION

Moringa oleifera plant belongs to the Moringaceae family. It is commonly known as the horse radish tree or drumstick tree. It is a small, medium-sized tree, reaching a height of 10-15 meters [1]. The tree is characterized by being a fast-growing type that tolerates drought, as it grows in areas that receive annual rainfall amounts ranging from 250 to 1500 mm [2,3]. Altitudes below 600 meters are considered the best for growing Moringa, but it can grow at altitudes above 2000 meters [2,4]. Slightly alkaline clay soil and sandy loam soil are the best media for growing Moringa because of their good drainage. Moringa tolerates a wide range of soil types and pH (4.5-9) but prefers well-drained soil

in the neutral pH range. *Moringa oleifera* has good adaptability to humid and dry climates [4].



Fig. 1 *Moringa oleifera* tree [5].

Moringa oleifera Lam. is the most cultivated species in the tropical Moringaceae family, which contains thirteen diverse species [6]. *Moringa* species can be differentiated based on leaf morphology and anatomy [7]. As shown in Image (۲).

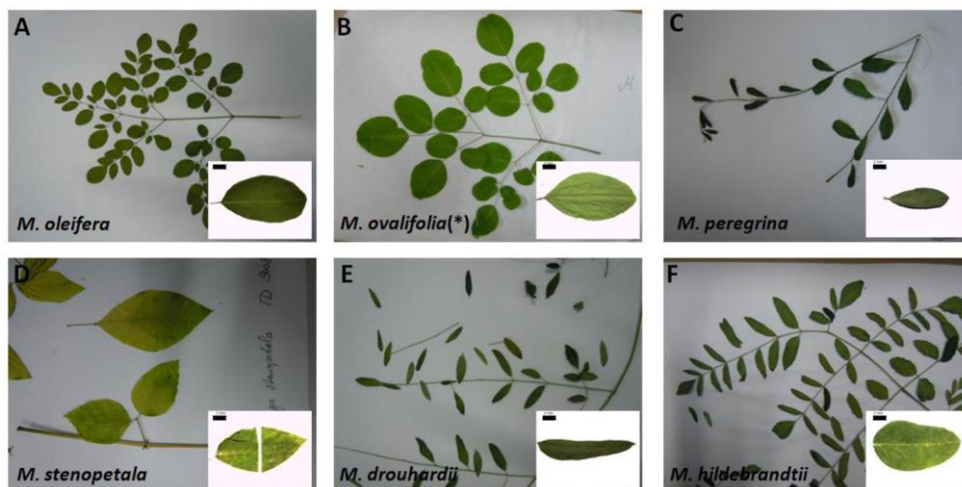


Fig. ۲. Images of single leaflets (inset) were recorded using a stereomicroscope at a magnification of 6.3x (scale bar in inset is 2 mm). (*) received as *M. ovalifolia*, by re-evaluation determined as *M. oleifera*. A *Moringa oleifera*, (B) *M. ovalifolia* (*), (C) *M. peregrina*, (D) *M. stenopetala*, (E) *M. drouhardii* and (F) *M. hildebrandtii* [8].

Moringa oleifera has gained importance due to its multi-purpose uses, as almost all parts of the plant are used, as it is one of the most widely used plants in the world [4,3]. *Moringa oleifera* tree is considered both nutritional and medicinal and contains some beneficial minerals, vitamins, amino acids and other nutrients. Almost all parts of this plant: root, bark, gum, leaves, fruit (pods), flowers, seeds and seed oil have been used to treat various diseases in traditional medicine in South Africa. Asia, including the treatment of infections and infectious diseases [8].

2. GEOGRAPHICAL LOCATION

Moringa is widely grown in tropical and subtropical regions [2]. It is native to the sub-Himalayan regions of northwest India. It is native to many countries in Africa, the Arabian Peninsula, Southeast Asia, the Pacific, the Caribbean Islands and South America [8].

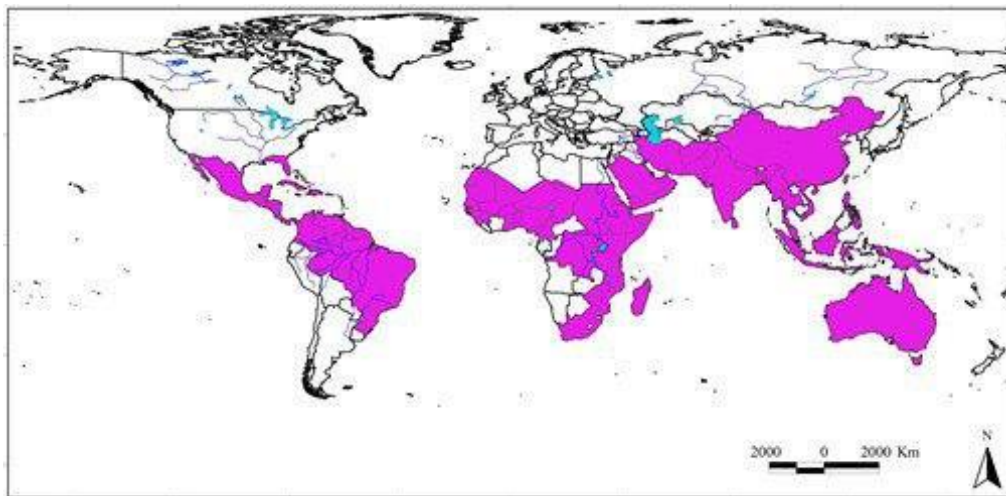


Fig. 3. Countries where *Moringa oleifera* has been recorded as either native or naturalised Adapted [9].

3. CHEMICAL COMPOSITION

Through a review of numerous studies on almost all parts of the *Moringa oleifera* plant, more than 90 compounds have been identified from the genus *Moringa*, many of which have therapeutic potential. The isolates fall into

the category of proteins, amino acids, phenolic acids, carotenoids, alkaloids, glucosinolates, flavonoids, sterols, terpenes, tannins, saponins, fatty acids, glycosides, and polysaccharides [10]. It also contains crude fiber, Reducing sugars, resins, organic acids, sterols, Tannins, proteins ,polyphenols, and antioxidants [11]. Tables 1 and 2 show the chemical composition and nutrients found in *Moringa oleifera* leaves per 100 g.

Table (1) The chemical composition of dried leaf powder of *Moringa oleifera* per 100 g of edible portion of leaves

Nutritional value per 100 g	Values
Moisture (%)	7.5
Calories (Kcal)	205
Fat (g)	2.3
Protein (g)	27.1
Fiber (g)	19.2
Magnesium (mg)	368
Calcium (mg)	2.003
Potassium (mg)	1.324
Phosphorus (mg)	204
Sodium (mg)	870
Iron (mg)	28.2
Vitamin A-Beta Carotene (mg)	16.3
Vitamin B ₁ thiamin (mg)	2.64
Vitamin B ₂ riboflavin (mg)	20.5

Vitamin B3- nicotinic acid (mg)	8.2
Vitamin C ascorbic acid (mg)	17.3
Vitamin E tocopherol acetate (mg)	113
Arginine (g 16 ⁻¹ g N)	1.33
Histidine (g 16 ⁻¹ g N)	0.61
Lysine (g 16 ⁻¹ gN)	1.32
Tryptophan (g 16 ⁻¹ gN)	0.43
Phenylalanine (g 16 ⁻¹ gN)	1.39
Methionine (g 16 ⁻¹ gN).	0.35
Threonine (g 16 ⁻¹ gN)	1.19
Leucine (g 16 ⁻¹ gN)	1.95
Isoleucine (g 16 ⁻¹ gN)	0.83
Valine (g 16 ⁻¹ gN)	1.06
Oxalic acid (mg)	1.6

Source: [4].

Table (2) The nutritional and energetic value, soluble sugars, and organic acids composition in fresh *M. oleifera* leaves. per 100 g of edible portion of leaves.

Crude protein (g/100 g dw)	22.8±0.3
Crude fat (g/100 g dw)	6.5±0.2
Total ash (g / 100g dw)	14.1±0.5
Mg (mg/100 g dw)	382±1

Na (mg/100 g dw)	319±0.5
Fe (mg/100g dw)	39±3
Cu (mg / 100 g dw)	0.81±0.01
Ca (mg / 100g dw)	2785±1
Mn (mg / 100g dw)	5.21±0.03
Zn (mg / 100g dw)	3.37±0.09
K (mg/100 g dw)	1626±1
Total carbohydrates (g / 100g dw).	56.6±0.5
Glucose (g/100 g dw)	0.420±0.004
Sucrose (g/100g dw)	3.04±0.07
Fructose (g/100 g dw)	0.36±0.02
Total soluble sugars (g/ 100 g dw)	3.82±0.09
Energetic value (Kcal/100 g dw)	376±1
Malic acid (g/100 g dw)	3.60±0.008
Ascorbic acid (mg/100 g dw)	6.7±0.2
Oxalic acid (g/100 g dw)	1.35±0.03
Total organic acids (g/100 g dw)	4.97±0.04

Source: [12].

As shown in the Tables 1 and 2 there is a difference in the amount of elements present in the same amount of *Moringa oleifera* leaves, as climatic and biological factors as well as the techniques used in agricultural engineering can also affect the composition of plants and the difference in the levels of nutrients in the plant, and thus the chemical composition of the plant varies

from one place to another [12]. It is also believed that the diversity of geographical location is one of the reasons for the difference in mineral composition of the same plant species [13]. Below we will review the Nutritive properties in *Moringa Oleifera*.

4. NUTRITIVE PROPERTIES

.4.1. Major elements

Chemical analysis of *Moringa* revealed that carbohydrates are the predominant compounds in the plant. In addition to the validity of the analysis results, *Moringa* leaves are a good source of protein and have special nutritional importance, as they may meet human needs for protein and energy [12]. This information has been confirmed by many previous studies, as *Moringa* is considered a rich source of protein when used in nutritional supplements because it contains high levels of protein [14].

Several studies have shown that *Moringa oleifera* leaves contain a low amount of fat. One study revealed that the amount of fat extracted from *Moringa oleifera* leaves in Ghana was 2.23 g/100 g. In the same study, it was also revealed that as for the amount of energy that can be taken from the leaves of the *Moringa oleifera* tree from Ghana, it is (about 310 kilocalories/100 grams) [15]. In *Moringa oleifera* tree from Ethiopia the commercial fat content ranges from 10.21 to 10.31 g/100 g [16].

.4.2. Minerals

Moringa oleifera leaves are rich in major and minor minerals. It has been noted through reviewing many studies that they contain a wide range of important minerals essential to the human diet, especially P, K, Ca, Mg, Mn, Fe, Al, Cu and Zn [17]. *Moringa oleifera* also contains a number of important vitamins, including: vitamins A, B complex (B1, B3, B6 and B7), C, D, E, and K [18].

Researchers reported that the mineral content of the South African *Moringa oleifera* leaf was as follows: calcium (3.65 g/100 g), phosphorus (0.3 g/100 g), magnesium (0.5 g/100 g), potassium (1.5 g/100 g), sodium (0.164 g/100 g),

sulfur (0.63 g/100 g), zinc (13.03 mg/kg), copper (8.25 mg/kg), manganese (86.8 mg/kg), iron (490 mg/kg), and selenium (363 mg/kg) [19].

Another study conducted revealed high values of the main elements extracted from *Moringa* olive oil found in Ethiopia, where the amount of elements was as follows: calcium (2016.5-2620.5 mg/100 g), potassium (1817-1845 mg/100 g), and magnesium (322.5-340.6 mg/100 g) [16].

4.3. Acids

Moringa oleifera contains three organic acids, where malic acid is the dominant organic acid, followed by oxalic acid and then ascorbic acid [12]. There are also many factors that affect fatty acids, especially external factors such as harvesting, storage, processing, processing steps and preparation, which result in the difference in the composition of organic acids [20]. *Moringa oleifera* leaves are a rich source of protein as mentioned above, and are also a very good source of essential amino acids such as methionine, cysteine, tryptophan and lysine [21]. *Moringa* leaves also contain olive oil and amino acids such as arginine and histidine [22].

Moringa oleifera leaves contain many phenolic acids such as gallic acid which is a major phenolic acid. Also, ellagic acid, ferulic acid, caffeic acid, o-coumaric acid, chlorogenic acid, gentisic acid, syringic acid and p-coumaric acid and sinapic acid [23].

Moringa oleifera plant contains many fatty acids, for example (Oleic acid, linoleic acid, myristic acid, palmitic acid, palmitoleic acid, stearic acid, arachidic acid, linolenic acid, behenic acid, and paullinic acid. The fatty acid content of *Moringa oleifera* oil varies depending on the location from which the oil was extracted. The most distinctive feature of *Moringa oleifera* seed oil is its light yellow color and nutty flavor. The most common type of fatty acid present in the seed oil is oleic acid, which constitutes 75-77% of the fatty acid composition of the seeds, While other vegetable oils typically contain only about 40% oleic acid [24,4].

4.4. Antioxidant compounds

Moringa oleifera leaves contain many antioxidant compounds such as

(polyphenol compounds, which play an important role in quenching singlet oxygen and decomposing peroxides) [25], *Moringa oleifera* leaves also contain other antioxidant compounds such as flavonoids, ascorbic acid, carotenoids and phenolics. Because of these compounds, *Moringa oleifera* leaves are considered antioxidants and antimicrobials [21].

Due to the presence of many antioxidants in the leaves of the Moringa, it is able to extend the shelf life of foods that contain fats. I am Also, Moringa had a set of unique compounds that contain sugar and ramn osis, who are ununcommon sugar modified glucosinolates. These compounds were reported to demonstrate certain chemopreventive activity, by inducing apoptosis [4].

Moringa leaves are a rich source of carotenoids, containing ≥ 2 mg/100 g (fresh weight), which is very useful in malnutrition programs to alleviate vitamin A deficiency. The carotenoid lutein is the most abundant type of carotenoids found in *Moringa oleifera* leaves [26]. Some researchers also reported that *Moringa oleifera* does not contain alpha-carotene, which is usually found in green leafy plants. Researchers assumed that all alpha-carotene was completely converted to lutein. However, some other carotenoids can be found in *Moringa oleifera*, for example (all-E-luteoxanthin , 13-Z-lutein , 15-Z- β -carotene , and all-E-zeaxanthin . Lupeol acetate , β -amyrin , and α -amyrin [24].

Moringa oleifera also contains alkaloids, and Several alkaloids have been isolated from *Moringa oleifera* leaves, for example (pyrrole alkaloid glycosides, marumosi A and marumosi B, pyrrolemarumine-4"-O- α -L-rhamnopyranoside) [27].

5. MEDICINAL PROPERTIES

Moringa oleifera Lam (Moringaceae) is a plant with high medicinal and nutritional value, and has a wonderful range of medicinal uses. Different parts of this plant contain a range of important minerals, and it is a good source of protein, vitamins and antioxidants, so it is used in the treatment of many diseases [28].

5.1. Diabetes

Moringa (*Moringa oleifera* Lam.) has long been used to treat diabetes because it is a medicinal plant. The leaves have been shown in experiments to lower blood sugar levels without any negative side effects. Consumption of *Moringa oleifera* leaf extract decreased plasma insulin, insulin resistance, and hepatic gluconeogenesis in rats fed a high-fat diet. This is due to the leaves being rich in a substance called (isothiocyanate). It is also believed that the reason for *Moringa* leaves lowering blood sugar is that they contain (the presence of quercetin-3-glucoside and fiber) [29].

It has also been shown to be biologically active compounds (4-hydroxyphenylacetone nitrile and fluoropyrazine, respectively) isolated from *Moringa oleifera* leaves significantly reduce blood glucose concentration in diabetic rats [30]. A study showed that crude polysaccharides extracted from *M. oleifera* leaves could effectively prevent weight gain, fat accumulation, lipid gain and chronic inflammation in obese mice induced by a high-fat diet [31].

In study, regular consumption of ethanolic extract of *Moringa oleifera* leaves (600 mg/kg-1 day-1) for 12 weeks resulted in lower blood sugar and improved insulin resistance without any side effects on kidney or liver function [32]. In another study shown that using *Moringa oleifera* leaf extract reduces blood glucose levels in diabetic rodents because *Moringa oleifera* leaves contain the chemical compound (Glucosinolates) which is converted by the endogenous enzyme myrosinase into thiocyanates, isothiocyanates, and nitriles which are active molecules that lower blood sugar [33].

These studies are consistent with a study conducted on postmenopausal women (45-60 years old), where 7 grams of *Moringa oleifera* leaves were taken daily for 3 months. The result was a decrease in fasting blood glucose by 13.5% [34].

Moringa leaf extract also works to regenerate damaged beta cells in the pancreas and stabilized expression of the gluconeogenic enzyme pyruvate carboxylase in the liver of the diabetic rats, through its antioxidant capacity, which makes it able to lower blood sugar levels [35]. *Moringa* leaf extract also

improves glycogen content and glucose uptake in the liver and muscles of diabetic rats [36].

5.2. Obesity

Eating *Moringa oleifera* seed oil extract contributes to reducing obesity resulting from fat intake, by enhancing antioxidant enzymes, reducing lipid peroxidation as well as inflammatory cytokines, and also improves blood and metabolic disorders resulting from following a high-fat diet [37]. *Moringa oleifera* leaves contain flavonoids that act as inhibitors of pancreatic lipase, a digestive enzyme responsible for breaking down dietary fats. Inhibition of this enzyme results in limited absorption of fats into the bloodstream, and as a result, produces an important alternative strategy for obesity management [38].

A study conducted showed that treating high-fat mice with oral doses of *Moringa oleifera* at 200 mg/kg and 400 mg/kg resulted in significant reductions in body weight and organ weight in the mice compared to mice fed a high-fat diet. *Moringa oleifera* is also able to maintain body weight and prevent the increase in current body weight, and the reduction in body weight depends on the amount of the dose taken [39]. This study is also consistent with a study in which *Moringa* seed extract was combined with a low-fat or high-fat diet and given to normal and obese male rats for 12 weeks respectively, it resulted in reduced body weight, decreased adiposity, and improved metabolic health through its anti-inflammatory and antioxidant activities [40].

Moringa oleifera administration resulted in a sharp increase in the body temperature of mice due to the overall stimulant and thermogenic property of the phytochemicals present in *Moringa oleifera* extract. *Moringa oleifera* contains a large amount of flavonoids, a large number of which work to increase heat generation in the living body [39,41]. Lower core body temperature has been linked to obesity in mice, as it has been shown that there is a relationship between temperature and metabolic rate, as metabolic rate increases by 10% to 13% when core body temperature rises by 1 degree Celsius, due to the effect of high temperature on oxygen consumption [42]. Accordingly, it has been shown that increasing body temperature leads to weight loss.

Another study says, When Moringa leaves, *Murraya koeingii*, and extract of *Curcuma longa* rhizome. The result is a herbal weight loss extract for overweight and obese people that reduces body fat mass, fat cell volume and body mass index in overweight and obese people and enhances intracellular lipolysis in fat cells and also significantly increases resting energy expenditure. This is done by increasing energy metabolism and also increasing the level of the hormone adiponectin in the serum, which is a key regulating hormone for energy metabolism that stimulates thermogenic activity in the body and generates heat in brown fat cells. The herbal compound also improved the level of T3, which is the metabolically active form of thyroid hormone; it increases energy expenditure through the metabolism of fats and carbohydrates [43].

5.3. Heart and atherosclerosis

Moringa oleifera has a protective effect on the heart and blood vessels as it contains high concentrations of flavonoids and phenolic acids, making it a good source of antioxidants. As a result, it can be used to treat increased oxidative stress, which has long been a common cause of cardiovascular disease [44].

Moringa oleifera leaf extract can lower plasma cholesterol, triglycerides and low-density lipoprotein (LDL). This is through a study that found that the results of plasma cholesterol, triglycerides and LDL levels in diabetic rats that were given aqueous *Moringa oleifera* leaf extract for 28 days were not significantly different from the results of the normal group. Furthermore, the saponins present in *Moringa oleifera* can inhibit the absorption of cholesterol by binding to bile acids, leading to a decrease in the intestinal circulation of bile acids and an increase in the levels of cholesterol excretion in the feces, leading to a decrease in plasma cholesterol [45]. As a result, it can be concluded that *Moringa oleifera* leaves reduce the rate of atherosclerosis.

Moringa oleifera lowers the heart rate during the night activity period without affecting the daytime heart rate and arterial blood pressure, which is beneficial for protecting blood vessels and the heart, as it was found that lowering the heart rate is associated with protecting blood vessels and the heart. *Moringa oleifera* seeds contain alkaloids which affect heart rate by regulating cholinergic function [46]. *Moringa oleifera* also lowers serum cholesterol, triglycerides, very low-density lipoprotein (VLDL), low-density lipoprotein

(LDL), and atherosclerosis index and increases good cholesterol (HDL) in rats fed a high-cholesterol diet [47].

In a study conducted on rats fed a high-fat diet, treatment with *Moringa oleifera* at doses of 200 mg/kg and 400 mg/kg for 3 weeks significantly reduced the atherosclerosis index, significantly reduced total cholesterol and LDL cholesterol levels and increased HDL cholesterol levels. Thus, we conclude that *Moringa oleifera* extract can be used for cardioprotection [39].

This study is consistent with a another study conducted to know the effect of *Moringa oleifera* extract on protecting the heart from diseases, the study was conducted on mice and lasted for a month during which the mice were given orally once daily an amount of *Moringa oleifera* (200 mg / kg) mixed with saline solution. The result of this study was that treatment with *Moringa oleifera* led to an increase in the level of HDL in the serum and a decrease in the levels of total cholesterol, LDL and triglycerides, as well as preventing a significant increase in fat oxidation in heart muscle tissue. From this, it can be concluded that *Moringa oleifera* has a protective effect on the heart, due to it being rich in antioxidants [48].

Moringa oleifera is also useful in treating drug-induced cardiac toxicity. In a study conducted the compound indole alkaloid (N, α -L-rhamnopyranosyl vincosamide) was extracted from *Moringa oleifera* leaves and this compound was fed orally to mice at a dose of 40 mg/kg daily for 7 days. The result was a significant decrease in the cardiac toxicity resulting from (isoproterenol-induced) in mice [49].

5.4. Liver

Moringa oleifera has a protective effect against liver diseases as it effectively protects the liver from hepatitis, improves cell necrosis and inflammatory changes, maintains the normal liver structure and improves liver performance because Moringa is rich in antioxidants [50]. It also increases the content of glutathione in the liver, as glutathione is the primary antioxidant in liver cells. This is because *Moringa oleifera* works as a powerful antioxidant as it contains polyphenolic [49]. The aqueous and alcohol extracts from Moringa flowers were also found to have a significant hepatoprotective effect , which

may be due to the presence of quercetin, a well-known flavonoid with hepatoprotective activity [51].

Moringa oleifera seed oil intake significantly improved the abnormal liver and kidney markers as well as histopathological lesions due to its antioxidant capacity and scavenging of singlet oxygen and free radicals [37].

Moringa oleifera also provides potential protection against high-fat diet-induced fatty liver by improving serum and liver metabolic markers [43]. In a study conducted to determine the effect of *Moringa oleifera* extract on the liver of mice fed a high-fat diet, the result was that the extract prevented the deposition of hepatic fat in liver cells and reduced liver enzymes, as the effect of increasing liver enzyme levels is associated with the formation of fatty liver [39].

Moringa oleifera leaf extract is also useful for protecting the liver from toxicity resulting from medical drugs (the hepatotoxicity), as it works to inhibit drug-induced lipid peroxidation in the liver and also reduce the levels of AST, ALT, ALP and bilirubin resulting from the drug [52]. *Moringa oleifera* leaf extract also reduces carbon tetrachloride-induced liver toxicity by increasing antioxidant enzymes and decreasing lipid peroxidation [53].

5.5. Kidney

There are many studies that have been conducted to determine the effect of *Moringa oleifera* extract on the kidneys, including: A study was conducted to know the effect of *Moringa oleifera* leaf extract on the kidneys of chickens, where *Moringa oleifera* leaf extract was given with gentamicin. The results were that *Moringa oleifera* leaf extract reduces nitric oxide in tissues and reduces oxidative stress and kidney damage caused by gentamicin in chickens [54].

A study was conducted to know the effect of using *Moringa oleifera* extract in treating kidney poisoning resulting from cadmium. This study was conducted on mice and continued for 4 weeks. The mice took a dose of 400 mg/kg of *Moringa* extract. The results of this study were that *Moringa oleifera* improves the biochemical parameters of kidney tissue and also works as an antioxidant resulting from oxidative stress resulting from cadmium due to its high content

of phenolic compounds [55]. It was also shown that *Moringa oleifera* leaf extract prevents nephrotoxicity caused by gentamicin [56].

Another study was conducted to know the effect of the aqueous extract of *Moringa oleifera* on diabetic nephropathy in rats, the results were that *Moringa oleifera* treated the glomeruli and renal tubules and alleviated the effects of diabetes complications on the kidneys and is believed to contribute to the restoration of kidney functions [57]. Also, the extract of (*Moringa oleifera* seed oil) has shown effectiveness in treating liver and kidney toxicity resulting from drugs, as it is able to regenerate the damaged ones and reduce inflammation levels, and it has also shown to have protective properties [58]. Through these studies, *Moringa oleifera* extract can be nominated as a potential treatment for kidney disease.

5.6. Cancer

Moringa oleifera contains a variety of bioactive compounds that can act as antioxidants, antibiotics, anti-inflammatory and anticancer agents, which can be obtained from different parts of the *Moringa oleifera* body. Isothiocyanates (ITCs) from *Moringa oleifera* are one of these active substances that can inhibit cancer proliferation and promote cancer cell death through multiple signaling pathways, thus suppressing cancer migration and metastasis, while having minimal harmful effect on normal cells [59]. *Moringa* also contains compounds that are isolated from it that act as cancer cell inhibitors, such as: thiocarbamate and isothiocyanate [10].

Moringa oleifera tree also contains a high amount of flavonoids and vitamins that work to boost the immune system by enhancing the immune response through lymphocytes and increasing the phagocytosis process [60]. The phenolic compounds present in *Moringa oleifera* have also been shown to have antitumor activity and also act as protective agents [61]. *Moringa oleifera* leaf extract has also been reported to inhibit acid-induced hydrogen peroxide-induced DNA damage and lipid peroxidation in cancer cells (human tumors) [62].

One study showed that *Moringa oleifera* leaf extract kills human cancer cells and prevents the proliferation of cancer cells, which is similar to the action of

the cancer drug (cisplatin). It is also suggested that *Moringa oleifera* leaf extract be given with cancer drugs to increase the effectiveness of drug and reduce its side effects [60]. Other studies have shown the possibility of using *Moringa oleifera* leaf extract as a treatment for cancer cells, as it works to prevent the growth and reproduction of cancer cells and stimulates their death. It also showed greater cytotoxicity towards cancer cells compared to normal cells [63].

5.7. Male fertility

Many reviews have revealed the potential use of *Moringa oleifera* as an aphrodisiac, *Moringa oleifera* has shown an effect in improving sexual behavior, reproductive function and the male reproductive system, as it works to increase the number of sperm cells, the diameter of the seminiferous tubules and the efficiency of sperm due to its richness in antioxidant compounds, phenols and flavonoids [63,64]. It has been shown too that taking *Moringa oleifera* leaf extract can reduce testicular dysfunction caused by chromium toxicity as well as decreased sperm quality and improve the quality of antioxidant enzymes [65].

A study was conducted to determine the effect of Moringa leaf extract on the characteristics of cryopreserved ram semen, where the ram was given orally a dose of Moringa leaf extract of 40 mg/kg. The result was that Moringa leaf extract increases the volume of semen and sperm concentration, significantly increases their motility after freezing, their viability index, membrane integrity and antioxidant enzyme activities in the semen after freezing, and also reduces acrosome yop and sperm DNA fragmentation in cryopreserved semen. This is done by improving the antioxidant defense mechanism in the seminal plasma, which results in improving the characteristics of semen, whether fresh or cryopreserved, for rams [66].

6. OTHER USES OF *MORINGA OLEIFERA*

There are other uses for the *Moringa oleifera* tree, as it works to lower blood pressure through compounds (thiocarbamate and isothiocyanate and glycosides) that were isolated from the pods of the *Moringa oleifera* tree [28]. *Moringa oleifera* is also an excellent nutritional supplement because it contains high concentrations of ascorbic acid, oestrogenic substances, beta-sitosterol, iron,

calcium, phosphorus, copper, vitamins A, B, C, alpha-tocopherol, riboflavin, nicotinic acid, folic acid, pyridoxine, beta-carotene, protein, and especially essential amino acids such as methionine, cysteine, tryptophan, and lysine. These substances are available in the seeds and leaves of *Moringa oleifera* [67].

Moringa leaves can act as an antiseptic and preservative that prevents the growth of *E. coli*, as they contain a chemical compound called pter-ygospermin, which easily breaks down into two molecules of benzyl isothiocyanate, which is known to have antimicrobial properties [21].

7. TOXICITY

To confirm the toxicity of the plant, acute toxicity study (5000 mg/kg) and subacute toxicity studies of the leaf extract (40 mg/kg to 1000 mg/kg) were performed in rats. Blood samples were evaluated for biochemical and hematological measurements. There were no overt adverse reactions observed in the acute and subacute studies. However, an increase in liver enzymes ALT and ALP ($P < 0.001$) and a decrease in creatinine levels were observed in the groups treated with the extract [68]. The dose taken should not exceed 5000 mg/kg, whether it is *M. oleifera* leaves infusion and powder, because rats showed a change in behavior within the first two hours of taking the 5000 mg/kg dose [69].

Caution should be taken when consuming *M. oleifera* powder on a regular basis, as it has been found to promote liver and kidney damage at 500/1000 mg/kg, which occurred after 28 days of regular consumption [69]. In order to determine the lethal dose of acute toxicity, animals were injected with a quantitative dose of 150 mg/ml every five minutes of *M. oleifera* leaf extract until death occurred. It was found that the lethal dose for mice was 6616.67 mg/kg body weight for mice and 26043.67 mg/kg body weight for rabbits. Upon autopsy, it was found that the cause of death was the injection of an excessive amount of fluid, and as a result it was concluded that the plant could have low toxicity when given in concentrated doses for a short period of time [70].

To prevent cumulative toxicity resulting from long-term consumption, daily intake should not exceed 70 grams [68]. Because increased consumption can lead to damage to the liver and kidney.

REFERENCES

- [1] C. Ramachandran, K.V. Peter, P.K. Gopalakrishnan, Drumstick (*Moringa oleifera*): A multipurpose Indian vegetable, *Econ. Bot* 34 (1980) 276–283. <https://doi.org/10.1007/BF02858648>.
- [2] T. Radovich, Farm and Forestry Production and Marketing Profile for Moringa (*Moringa oleifera*). In: C.R. Elevitch (ed.), Specialty Crops for Pacific Island Agroforestry, Permanent Agriculture Resources (PAR), Holualoa, Hawai‘i, (2011). <http://agroforestry.net/scps>.
- [3] M.C. Palada, L.C. Chang, Suggested cultural practices for Moringa, International Cooperators Guide, AVRDC Publication Number 03-545: 1-5, (2003).
- [4] K. Gandji, F.J. Chadare, R. Idohou, V.K. Salako, A.E. Assogbadjo, R.G. Kakai, Status and utilisation of *Moringa oleifera* Lam: A review, *African Crop Science Journal* 26 (2018) 137-156.
- [5] J.O. Popoola, O.O. Obembe, Local knowledge, use pattern and geographical distribution of *Moringa oleifera* Lam. (Moringaceae) in Nigeria, *Journal of Ethnopharmacology* 150 (2013) 682–691. <https://doi.org/10.1016/j.jep.2013.09.043>.
- [6] U. Shahzad, M.A. Khan, M.J. Jaskani, I.A. Khan, S.S. Korban, Genetic diversity and population structure of *Moringa oleifera*, *Conservation Genetics* 14 (2013) 1161–1172.
- [7] S. Wetters, V. Sahi, L. Brosche, et al., Monitoring Indian “Superfood” *Moringa oleifera* Lam. – species-specific PCR-fingerprint-based authentication for more consumer safety, *npj Sci Food* 8 (2024) 21. <https://doi.org/10.1038/s41538-024-00264-z>.
- [8] V. Sharma, R. Paliwal, P. Sharma, S. Sharma, Phytochemical analysis and evaluation of antioxidant activities of hydro-ethanolic extract of *Moringa oleifera* Lam. Pods, *Journal of Pharmacy Research* 4 (2011) 554–557.
- [9] S. Navie and S. Csurhes, Weed risk assessment: Horseradish tree, *Moringa oleifera*, Biosecurity Queensland, Department of Employment, Economic Development and Innovation, Queensland Government, (2010) 26 pp.

- [10] A. Pareek, M. Pant, M.M. Gupta, P. Kashania, Y. Ratan, V. Jain, A. Pareek, and A.A. Chuturgoon, "*Moringa oleifera*: An Updated Comprehensive Review of Its Pharmacological Activities, Ethnomedicinal, Phytopharmaceutical Formulation, Clinical, Phytochemical, and Toxicological Aspects," Int. J. Mol. Sci. 24, no. 3 (2023) 2098. <https://doi.org/10.3390/ijms24032098>.
- [11] G. Mishra, P. Singh, and R. Verma, "Traditional Uses, Phytochemistry and Pharmacological Properties of *Moringa oleifera* Plant: An Overview," Der Pharmacia Lettre 3, no. 2 (2011) 141–164.
- [12] B.E.C. Ziani, W. Rached, K. Bachari, M. Alves, R. Calhelha, L. Barros, I. Ferreira, Detailed chemical composition and functional properties of *Ammodaucus leucotrichus* Cross. & Dur. and *Moringa oleifera* Lamarck, J. Funct. Foods 53 (2019) 237–247.
- [13] T.C.S.P. Pires, M.I. Dias, L. Barros, M.J. Alves, M.B.P.P. Oliveira, C. Santos-Buelga, I.C.F.R. Ferreira, Antioxidant and antimicrobial properties of dried Portuguese apple variety (*Malus domestica* Borkh. cv Bravo de Esmolfe), Food Chem. 240 (2018) 701–706. <https://doi.org/10.1016/j.foodchem.2017.08.010>.
- [14] A.T. Oyeyinka, S.A. Oyeyinka, *Moringa oleifera* as a food fortificant: Recent trends and prospects, J. Saudi Soc. Agric. Sci. 17 (2018) 127–136. <https://doi.org/10.1016/j.jssas.2016.02.002>.
- [15] I. Oduro, W.O. Ellis, D. Owusu, Nutritional potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves, Sci. Res. Essay, 3 (2008) 57–60.
- [16] T.G. Amabye, Chemical compositions and nutritional value of *Moringa oleifera* available in the market of Mekelle, J. Food Nutr. Sci., 3 (2016) 187–190.
- [17] K.A. Witt, The nutrient content of *Moringa oleifera* leaves, ECHO Res. Note, 1 (2013) 10–20.
- [18] N. Venkatesh, K.G. Devi, G. Venkateswarlu, A.M.S. Sudhakar, Effect of hydroalcoholic extract of *Moringa oleifera* leaves on fertility hormone and sperm quality of male albino mice, World J. Curr. Med. Pharm. Res. 1 (2019) 83–87.

- [19] B. Moyo, P.J. Masika, A. Hugo, V. Muchenje, Nutritional characterization of *Moringa oleifera* (Lam.) leaves, *Afr. J. Biotechnol.* 10 (2011) 12925–12933. <https://doi.org/10.5897/AJB10.1599>
- [20] M.I. Dias, L. Barros, P. Morales, M. Cámara, M.J. Alves, M.B.P.P. Oliveira, I.C.F.R. Ferreira, Wild *Fragaria vesca* L. fruits: a rich source of bioactive phytochemicals, *Food Funct.* 7 (2016) 4523–4532. <https://doi.org/10.1039/C6FO01042C>.
- [21] B.C. Jayawardana, R. Liyanage, N. Lalantha, S. Iddamalgoda, P. Weththasinghe, Antioxidant and antimicrobial activity of drumstick (*Moringa oleifera*) leaves in herbal chicken sausages, *LWT - Food Sci. Technol.* 64 (2015) 1204–1208. <https://doi.org/10.1016/j.lwt.2015.07.028>.
- [22] K.T. Mahmood, T. Mugal, I.U. Haq, *Moringa oleifera*: A natural gift—A review, *J. Pharm. Sci. Res.* 2 (2010) 775–781.
- [23] A. Leone, G. Fiorillo, F. Criscuoli, S. Ravasenghi, L. Santagostini, G. Fico, et al., Nutritional characterization of phenolic profiling of *Moringa oleifera* leaves grown in Chad, Sahrawi refugee camps, and Haiti, *Int. J. Mol. Sci.* 15 (2015) 18923–18937.
- [24] N.Z. Abd Rani, K. Husain, E. Kumolosasi, *Moringa* genus: A review of phytochemistry and pharmacology, *Front. Pharmacol.* 9 (2018) 108.
- [25] G. Cao, E. Sofic, R.L. Prior, Antioxidant and prooxidant behavior of flavonoids: structure-activity relationships, *Free Radic. Biol. Med.* 22 (1997) 749–760.
- [26] R.K. Saini, N.P. Shetty, P. Giridhar, Carotenoid content in vegetative and reproductive parts of commercially grown *Moringa oleifera* Lam. cultivars from India by LC–APCI–MS, *Eur. Food Res. Technol.* 238 (2014) 971–978. <https://doi.org/10.1007/s00217-014-2174-3>.
- [27] P. Sahakitpichan, C. Mahidol, W. Disadee, S. Ruchirawat, T. Kanchanapoom, Unusual glycosides of pyrrole alkaloid and 4'-hydroxyphenylethanamide from leaves of *Moringa oleifera*, *Phytochemistry* 72 (2011) 791–795. <https://doi.org/10.1016/j.phytochem.2011.02.021>.
- [28] F. Anwar, S. Latif, M. Ashraf, A.H. Gilani, *Moringa oleifera*: A food plant with multiple medicinal uses, *Phytother. Res.* 21 (2007) 17–25.

- [29] J. Ahmad, I. Khan, R. Blundell, *Moringa oleifera* and glycemic control: A review of current evidence and possible mechanisms, *Phytother. Res.* 33 (2019) 2841–2848.
- [30] R.M. Hafizur, K. Maryam, A. Hameed, L. Zaheer, S. Bano, S. Sumbul, S. Faizi, Insulin-releasing effect of some pure compounds from *Moringa oleifera* on mice islets, *Med. Chem. Res.* 27 (2018) 1408–1418.
- [31] L. Li, L. Ma, Y. Wen, J. Xie, L. Yan, A. Ji, Y. Zeng, Y. Tian, J. Sheng, Crude polysaccharide extracted from *Moringa oleifera* leaves prevents obesity in association with modulating gut microbiota in high-fat diet-fed mice, *Front. Nutr.* 9 (2022). <https://doi.org/10.3389/fnut.2022.861588>.
- [32] F.M. Metwally, H.M. Rashad, H.H. Ahmed, A.A. Mahmoud, E.R. Abdol Raouf, A.M. Abdalla, Molecular mechanisms of the anti-obesity potential effect of *Moringa oleifera* in the experimental model, *Asian Pac. J. Trop. Biomed.* 7 (2017) 214–221. <https://doi.org/10.1016/j.apjtb.2016.12.007>.
- [33] S. Watanabe, H. Okoshi, S. Yamabe, M. Shimada, *Moringa oleifera* Lam. in diabetes mellitus: A systematic review and meta-analysis, *Molecules.* 26 (2021) 3513. <https://doi.org/10.3390/molecules26123513>.
- [34] S. Kushwaha, P. Chawla, A. Kochhar, Effect of supplementation of drumstick (*Moringa oleifera*) and amaranth (*Amaranthus tricolor*) leaf powder on antioxidant profile and oxidative status among postmenopausal women, *J. Food Sci. Technol.* 51 (2014) 3464–3469.
- [35] A. Abd El Latif, S. El Bialy Bel, H.D. Mahboub, M.A. Abd Eldaim, *Moringa oleifera* leaf extract ameliorates alloxan-induced diabetes in rats by regeneration of beta cells and reduction of pyruvate carboxylase expression, *Biochem. Cell Biol.* 92 (2014) 413–419.
- [36] L.A. Olayaki, J.E. Irekpita, M.T. Yakubu, O.O. Ojo, Methanolic extract of *Moringa oleifera* leaves improves glucose tolerance, glycogen synthesis and lipid metabolism in alloxan-induced diabetic rats, *J. Basic Clin. Physiol. Pharmacol.* 26 (2015) 585–593.
- [37] O.E. Kilany, H.M.A. Abdelrazek, T.S. Aldayel, S. Abdo, M.M.A. Mahmoud, Anti-obesity potential of *Moringa oleifera* seed extract and lycopene on high fat diet-induced obesity in male Sprague Dawley rats, *Saudi J. Biol. Sci.* 27 (2020) 2733–2746. <https://doi.org/10.1016/j.sjbs.2020.06.026>.

- [38] I. Nallamuthu, A. Jain, T. Anand, Comparative evaluation of *Brassica oleracea*, *Ocimum basilicum*, and *Moringa oleifera* leaf extracts on lipase inhibition and adipogenesis in 3T3-L1 adipocytes, *J. Food Biochem.* 46 (2022) e14158. <https://doi.org/10.1111/jfbc.14158>.
- [39] S. Bais, G.S. Singh, R. Sharma, Antiobesity and hypolipidemic activity of *Moringa oleifera* leaves against high fat diet-induced obesity in rats, *J. Adv. Biol.* (2014), Article ID 162914. <https://doi.org/10.1155/2014/162914>.
- [40] A. Jaja-Chimedza, L. Zhang, K. Wolff, B.L. Graf, P. Kuhn, K. Moskal, R. Carmouche, S. Newman, J.M. Salbaum, I. Raskin, A dietary isothiocyanate-enriched *Moringa oleifera* seed extract improves glucose tolerance in a high-fat-diet mouse model and modulates the gut microbiome, *J. Funct. Foods.* 47 (2018) 376–385. <https://doi.org/10.1016/j.jff.2018.05.056>.
- [41] X. Zhang, X. Li, H. Fang, F. Guo, F. Li, A. Chen, S. Huang, Flavonoids as inducers of white adipose tissue browning and thermogenesis: signaling pathways and molecular triggers, *Nutr. Metab.* 16 (2019) 47.
- [42] L. Landsberg, J.B. Young, W.R. Leonard, R.A. Linsenmeier, F.W. Turek, Is obesity associated with lower body temperatures? Core temperature: a forgotten variable in energy balance, *Metab. Clin. Exp.* 58 (2009) 871–876.
- [43] S. Kundimi, K.C. Kavungala, S. Sinha, V.N.R. Tayi, N.R. Kundurthi, T. Golakoti, B. Davis, K. Sengupta, Combined extracts of *Moringa oleifera*, *Murraya koeingii* leaves, and *Curcuma longa* rhizome increases energy expenditure and controls obesity in high-fat diet-fed rats, *Lipids Health Dis.* 19 (2020) 198. <https://doi.org/10.1186/s12944-020-01376-7>.
- [44] M. Louisa, C.G.H. Patintingan, B.W.K. Wardhani, *Moringa oleifera* Lam. in cardiometabolic disorders: A systematic review of recent studies and possible mechanism of actions, *Front. Pharmacol.* 13 (2022) 792794. <https://doi.org/10.3389/fphar.2022.792794>.
- [45] T. Oyedepo, S. Babarinde, T. Ajayeoba, Evaluation of anti-hyperlipidemic effect of aqueous leaves extract of *Moringa oleifera* in alloxan-induced diabetic rats, *Int. J. Biochem. Res. Rev.* 3 (2013) 162–170.
- [46] J.I. Randriamboavonjy, G. Loirand, N. Vaillant, B. Lauzier, S. Derbré, S. Michalet, P. Pacaud, A. Tesse, Cardiac protective effects of *Moringa oleifera* seeds in spontaneous hypertensive rats, *Am. J. Hypertens.* 29 (2016) 873–881. <https://doi.org/10.1093/ajh/hpw001>.

- [47] S.M. Ezzat, M.H. El Bishbishy, N.M. Aborehab, M.M. Salama, A. Hasheesh, A.A. Motaal, H. Rashad, F.M. Metwally, Upregulation of MC4R and PPAR- α expression mediates the anti-obesity activity of *Moringa oleifera* Lam. in high-fat diet-induced obesity in rats, J. Ethnopharmacol. 251 (2020) 112541. <https://doi.org/10.1016/j.jep.2020.112541>.
- [48] M. Nandave, S.K. Ojha, S. Joshi, S. Kumari, D.S. Arya, *Moringa oleifera* leaf extract prevents isoproterenol-induced myocardial damage in rats: Evidence for an antioxidant, antiperoxidative, and cardioprotective intervention, J. Med. Food 12 (2009) 47–55. <https://doi.org/10.1089/jmf.2007.0563>.
- [49] S.J. Stohs, M.J. Hartman, Review of the safety and efficacy of *Moringa oleifera*, Phytother. Res. 29 (2015) 796–804. <https://doi.org/10.1002/ptr.5325>.
- [50] N. Younis, M.I. Khan, T. Zahoor, M.N. Faisal, Phytochemical and antioxidant screening of *Moringa oleifera* for its utilization in the management of hepatic injury, Front. Nutr. 9 (2022) 1078896. <https://doi.org/10.3389/fnut.2022.1078896>.
- [51] K. Ruckmani, S. Kavimani, R. Anandan, B. Jaykar, Effect of *Moringa oleifera* Lam. on paracetamol-induced hepatotoxicity, Indian J. Pharm. Sci. 60 (1998) 33–35.
- [52] L. Pari, N.A. Kumar, Hepatoprotective activity of *Moringa oleifera* on antitubercular drug-induced liver damage in rats, J. Med. Food 5 (2002) 171–177.
- [53] S. Sreelatha, P.R. Padma, Protective mechanisms of *Moringa oleifera* against CCl₄-induced oxidative stress in precision-cut liver slices, Forsch. Komplementmed. 17 (2010) 189–194.
- [54] N. Arafat, W. Awadin, R. ElShafei, V. El-Metwalley, R. Saleh, Protective role of *Moringa oleifera* leaves extract against gentamicin-induced nephro- and hepato-toxicity in chickens, Alex. J. Vet. Sci. 58 (2018) 173.
- [55] A. Saleh, Evaluation of hepatorenal protective activity of *Moringa oleifera* on histological and biochemical parameters in cadmium intoxicated rats, Toxin Rev. 38 (2018) 1–8. <https://doi.org/10.1080/15569543.2018.1478859>.

- [56] M. Ouédraogo, A. Lamien-Sanou, N. Ramdé, A.S. Ouédraogo, M. Ouédraogo, S.P. Zongo, O. Goumbri, P. Duez, P.I. Guissou, Protective effect of *Moringa oleifera* leaves against gentamicin-induced nephrotoxicity in rabbits, *Exp. Toxicol. Pathol.* 65 (2013) 335–339. <https://doi.org/10.1016/j.etp.2011.11.006>.
- [57] H. Akpan, A. Akande, A. Ojewale, F. Oladipupo, O.F. Akinpelu, S.M. Jimoh, *Moringa oleifera* ameliorates nephropathic changes in alloxan-induced diabetic adult Wistar rats, *J. Afr. Assoc. Physiol. Sci.* 6 (2018) 110–118.
- [58] S.W.A. Adeoye, O.S. Adeshina, M.G. Yusuf, A. Omole, Hepatoprotective and renoprotective effect of *Moringa oleifera* seed oil on dichlorvos-induced toxicity in male Wistar rats, *Niger. J. Physiol. Sci.* 37 (2022) 119–126.
- [59] Y.Y. Wu, Y.M. Xu, A.T.Y. Lau, Anti-cancer and medicinal potentials of *Moringa* isothiocyanate, *Molecules* 26 (2021) 7512. <https://doi.org/10.3390/molecules26247512>.
- [60] C. Tiloke, K. Anand, R.M. Gengan, A.A. Chuturgoon, *Moringa oleifera* and their phytonanoparticles: Potential antiproliferative agents against cancer, *Biomed. Pharmacother.* 108 (2018) 457–466. <https://doi.org/10.1016/j.biopha.2018.09.060>.
- [61] E.R.M. Zunica, S. Yang, A. Coulter, C. White, J.P. Kirwan, L.A. Gilmore, *Moringa oleifera* seed extract concomitantly supplemented with chemotherapy worsens tumor progression in mice with triple negative breast cancer and obesity, *Nutrients* 13 (2021) 2923. <https://doi.org/10.3390/nu13092923>.
- [62] S. Sreelatha, P.R. Padma, Modulatory effects of *Moringa oleifera* extracts against hydrogen peroxide-induced cytotoxicity and oxidative damage, *Hum. Exp. Toxicol.* 30 (2011) 1359–1368.
- [63] A. Singh, Navneet, Ethnomedicinal, pharmacological and antimicrobial aspects of *Moringa oleifera* Lam.: A review, *J. Phytopharmacol.* 7 (2018) 45–50.
- [64] J. Laoung-On, K. Saenphet, C. Jaikang, P. Sudwan, Effect of *Moringa oleifera* Lam. Leaf Tea on Sexual Behavior and Reproductive Function in Male Rats, *Plants (Basel, Switzerland)* 10 (2021) 2019. <https://doi.org/10.3390/plants10102019>.

- [65] K.M. Sadek, Chemotherapeutic efficacy of an ethanolic *Moringa oleifera* leaf extract against chromium-induced testicular toxicity in rats, *Andrologia* 46 (2014) 1047–1054. <https://doi.org/10.1111/and.12196>.
- [66] D.M. Shokry, M.R. Badr, S.H. Orabi, H.K. Khalifa, H.R. El-Seedi, M.A. Abd Eldaim, *Moringa oleifera* leaves extract enhances fresh and cryopreserved semen characters of Barki rams, *Theriogenology* 153 (2020) 133–142. <https://doi.org/10.1016/j.theriogenology.2020.04.007>.
- [67] H.P.S. Makkar, K. Becker, Nutritional value and antinutritional components of whole and ethanol extracted *Moringa oleifera* leaves, *Animal Feed Science and Technology* 63 (1996) 211–228. [https://doi.org/10.1016/S0377-8401\(96\)01023-1](https://doi.org/10.1016/S0377-8401(96)01023-1).
- [68] I.J. Asiedu-Gyekye, S. Frimpong-Manso, C. Awortwe, D.A. Antwi, A.K. Nyarko, Micro- and macroelemental composition and safety evaluation of the nutraceutical *Moringa oleifera* leaves, *Journal of Toxicology* 2014 (2014) 786979. <https://doi.org/10.1155/2014/786979>.
- [69] M.C. de Barros, A.G.B. Silva, T.G.D.S. Souza, C.A. Chagas, J.C.B. Machado, M.R.A. Ferreira, L.A.L. Soares, V.L. Xavier, L.C.C. de Araújo, E.F.O. Borba, T.G. da Silva, R.R.V. Alves, L.C.B.B. Coelho, A.M. de Oliveira, T.H. Napoleão, P.M.G. Paiva, Evaluation of acute toxicity, 28-day repeated dose toxicity, and genotoxicity of *Moringa oleifera* leaves infusion and powder, *Journal of Ethnopharmacology* 296 (2022) 115504. <https://doi.org/10.1016/j.jep.2022.115504>.
- [70] H. Ibrahim, M. Shayoub, B. Em, F. Ao, M. Ahmed, B. Osman, M.E. Shayoub, T. Kk, Assessment of acute toxicity and LD50 of *Moringa oleifera* ethanolic leaf extract in albino rats and rabbits, *Journal of Medical and Biological Science Research* 1 (2015) 38–43.

المورينجا أوليفيرا: مراجعة لأهميتها الغذائية وخصائصها الطبيعية وخصائصها الكيميائية.

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الملخص العربي

تُزرع المورينجا أوليفيرا، المعروفة أيضًا باسم شجرة الطبل، على نطاق واسع في المناطق الاستوائية وشبه الاستوائية. وهي من أكثر النباتات استخدامًا حول العالم، حيث تُستخدم جميع أجزائها تقريبًا في المجالات الطبية والتجارية. تحتوي أوراقها على فيتامينات ومعادن متنوعة، وتُعد مصدرًا جيدًا للبروتين والأحماض الأمينية. تتميز المورينجا أوليفيرا بخصائص طبية مهمة، بما في ذلك تأثيراتها المضادة للسرطان والسكري والميكروبات. بالإضافة إلى ذلك، أظهرت هذه النبتة قدرتها على خفض ضغط الدم ومستويات الكوليسترول ووزن الجسم، مع تحسين وظائف الكبد والكلية وتعزيز خصوبة الرجال. ونظرًا لمحتواها العالي من مضادات الأكسدة، تُستخدم المورينجا أوليفيرا أيضًا كمادة حافظة طبيعية في صناعة الأغذية. تستكشف هذه المراجعة التركيب الكيميائي، والتطبيقات الطبية، بالإضافة إلى سُميتها المحتملة.

الكلمات المفتاحية: المورينجا أوليفيرا، القيمة الغذائية، المركبات النشطة بيولوجيًا، مضادات الأكسدة، المواد الكيميائية النباتية، الخصائص الطبية، التطبيقات العلاجية، التركيب الكيميائي.

الكلمات المفتاحية: المورينجا أوليفيرا، القيمة الغذائية، المركبات الحيوية النشطة، مضادات الأكسدة، المركبات الكيميائية النباتية، الخصائص الدوائية، التطبيقات العلاجية والتركيب الكيميائي.