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Extraction and Pharmacological Activities of *Moringa oleifera* Leaves

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ABSTRACT

This literature review aimed to bring new insights into the field. Details to help future researchers find novel therapeutic compounds from the Moringa oleifera Lam. (*Moringaceae*) medicinal plant. This study explores the extraction methods and key properties of Moringa oleifera, a versatile plant known for its nutritional and medicinal value. Various extraction techniques, including solvent extraction, and aqueous extraction, ultrasound-assisted microwave, percolation, Decoction, pressured hot water, Ethanolic, and Soxhlet are investigated to obtain valuable compounds such as Moringa oil, proteins, and bioactive components. The properties of Moringa extracts, including antioxidant activity, antimicrobial potential, hypertensive, Antimalarial, antibacterial, Antitumor and nutritional content, are analyzed. The findings reveal the diverse applications of Moringa extracts in food, pharmaceuticals, and environmental sustainability, showcasing its potential as a valuable resource for various industries.

INTRODUCTION:

This literature review aimed to bring new insights into the field. Details to help future researchers find novel therapeutic compounds from the Moringa oleifera Lam. (Moringaceae) medicinal plant. This study explores the extraction methods and key properties of Moringa oleifera, a versatile plant known for its nutritional and medicinal value. Various extraction techniques, including solvent extraction, and aqueous extraction, ultrasound-assisted microwave, percolation, Decoction, pressured hot water, Ethanolic, Soxhlet are investigated to obtain valuable compounds such as Moringa oil, proteins, and bioactive components. The properties of Moringa extracts, including antioxidant activity, antimicrobial potential, hypertensive, Antimalarial, antibacterial, Antitumor and nutritional content, are analyzed. The findings reveal the diverse applications of Moringa extracts in food, pharmaceuticals, and environmental sustainability, showcasing its potential as a valuable resource for various industries. [1-3]

Fig.1 *Moringa oleifera* powder

MATERIALS AND METHODS –

Collection of plant material:

From the herbal garden, leaves were taken from the Moringa oleifera plant. The plant's health and lack of infection were confirmed. The leaves were properly cleaned and dried after being washed under running water to get rid of dust and other foreign objects. Enter your desired changes in this section. Then, use the button below to paraphrase. It really is that simple.

Fig.2 *Moringa Oleifera* plant

Extraction Method of *Moringa olifera*:

1. Prepare crude extracts of moringa leaves:

The first step in the extraction of *Moringa olifera* from a local Chennai market, fresh MOL was purchased. After being thoroughly washed, the leaves were dried for 10 days at room temperature. It was powdered after it was weighed.

2. Prepare aqueous Moringa extracts as follows:

Phytochemicals and minerals were isolated from the dry leaf powder of moringa trees growing in tropical and subtropical regions with rich mineral soil by Berkovich et.al. To create the derived aqueous moringa extract, 10 mL of boiling water and 1 g of dry moringa leaf powder were combined and stirred for 5 minutes. The mixture was then filtered twice through 2 mm of sterile filter paper and placed in a sterile tube. For each set of studies, this aqueous extract stock solution (100 mg/mL) was freshly made and kept for each set of trials should be kept at 4 °C for no more than 5 days Elzaawely et al. collected fresh moringa leaves from trees produced at Tanta University's experimental farm in Egypt rather than utilizing dry leaf powder. Their investigation used Phiri and Mbewe's. procedures, who made the aqueous extract of moringa at a 1:10 (w/v) ratio and combined 30 g of freshly picked leaves (immediately after collection) with 300 mL of distilled water for 15 minutes in a home blender. The solution was then passed through muslin fabric by the authors before being diluted with distilled water in three different ratios (1:20, 1:30, and 1:40) and applied to the crops although using water as a solvent does not generally produce a high yield, aqueous extraction of moringa has become more and more popular in recent years among farmers,

particularly smallholder and subsistence farmers, because water is more easily accessible, environmentally friendly, and affordable than other solvents like methanol and alcohol [4-10].

3. Ethanolic Extraction of MOL:

One Liter of 100 percent pure ethanol was added to 100 grams of the powdered leaves, and it was macerated for 72 hours. After filtering, the procedure was done twice for 48 and then 24 hours using the same solvent. The resultant pooled extracts were further concentrated using rotational flash, further concentrated using a vacuum desiccator, and then conserved at 4°C.

4. Pressurized Hot Water Extraction (PHWE) of Moringa Leaves:

Nuapia et al. created this non-organic solvent-based extraction technique. These writers modified the hot water pressure extraction technique as reported by Matshedido et al.for their purposes. In each run, 5 g of moringa leaf powder and 5 g of diatomaceous earth were combined to fill a PHWE cell. For 10 minutes, a PHWE cell was pre-heated and loaded with moringa leaf powder and diatomaceous earth different temperature and time variables were present during the extraction process. The vessels obtained during the extraction process were then covered with aluminium foil and preserved at a low temperature (in a cooler box filled with ice) to prevent the degradation of any delicate bioactive components. Following each extraction cycle, the moringa leaf extracts were gathered, placed in centrifuge tubes, and maintained at 18 ◦C for subsequent examination of the bioactive components. It should be mentioned that although water is the most common liquid found in nature, using it in this extraction method makes it harder to concentrate the extracts. This is because water vaporizes at a higher temperature than organic solvents like methanol and ethanol. Furthermore, the extraction procedure consumes a lot of energy in the few instances where the water solvent needs to be eliminated by evaporation [11-13].

5. Preparation of MLE Using Chemical-Based Solvents:

With a few minor alterations, Ngcobo and Bertling constructed MLE in accordance with Makkar and Becker. Briefly, 675 mL of 80% methanol and 20 g of fresh, young moringa leaves were combined. Before the solution was filtered through the Whatman No. 2 filter paper, the suspension was homogenized to extract the greatest quantity and variety of phytochemicals. with distilled water, the extract was diluted to three strengths (20, 50, and 80% of the initially produced MLE). Directly into the leaves of cherry tomato plants, these dilutions were sprayed to cause runoff. In contrast, Vongsak et al. crushed fresh and dried

moringa leaves into small pieces and soaked them in 70% ethanol for 72 hours at ambient temperature (28 °C) with periodic shaking. After filtering the extract, the leftover material was once again steeped in the same solvent until the extraction was clear. The most popular technique is using organic solvents. Many publications have adopted this method of extracting chemicals from moringa plant sections. Furthermore, since the chemical-based solvents used to extract the beneficial chemicals from moringas leaves are volatile, some of the MLE applied topically to plants evaporates before it can be absorbed. It is advised to use MLEs before dawn or after nightfall or to soak the soil to combat this. Additionally, it is advised to dilute chemical-based extracts to a lower percentage because methanol in particular is particularly poisonous. [14-20]

6. Soxhlet extraction of dried leaves (SD50 and SD70):

The dried powdered leaves were separately placed into a thimble and were extracted with 50 and 70% ethanol (1:50, w/v) in a Soxhlet apparatus. Extraction was carried out at five cycles/h until exhaustion (20h). The combined extract from each extraction system (except squeezing) was independently filtered through a Whatman No. 1 sludge paper. The filtrate was dried under reduced pressure at 50 ◦C using a rotary vacuum evaporator. The crude extract was weighed and kept in a tight container protected from lights [21].

7.Ultrasound-Assisted Extraction:

An ultrasonic processor UP200S sonifier (200 W, 24 kHz) from Hielscher Ultrasonics GmbH, Teltow, Germany, was used for the UAE process. It has ultrasonic cycle and amplitude control. Additionally, a Micro-tip S7 probe from Heinrich Ultrasonics GmbH in Teltow, Germany, with the following features was used: maximum immersed depth of 90 mm, diameter of 7 mm, maximum amplitude of 175 m, and acoustic power density of 300 W cm^2. A thermostatic bath was used to regulate the temperature, allowing the temperature to be set by each experimental condition. The extractions were performed in 50 mL “Falcon” tubes. The sample weight was about 0.2 g, and the appropriate volume of solvent was added for each experiment in order to maintain the desired temperature by the thermostatic bath settings, the Falcon tubes containing the samples were put within a double-walled container. each experiment’s temperature, cycle, and amplitude were set in the experiment design, and a 10-minute extraction period was employed for each experiment. the extract was centrifuged at 5985 g for 5 min after the extractions were finished. A 25 mL volumetric flask was added with the supernatant .and then the precipitate re dissolved by 5m of Extraction. Solvent the

same procedure was used to centrifuge this second extract once again, and the supernatant was then transferred to the identical volumetric flask before being rinsed. Until analysis, the finished extracts were kept in a freezer at 20 °C. Using aqueous acetone as a solvent (70%, v/v), the phenolic compounds in the samples (2 g) were extracted. We looked at the effects of the extraction temperature (55-65°c), extraction time (20–30 min), and SS ratio (25–35 mL/g). A German Elmasonic S60 H, 550 W ultrasonic bath was used to conduct the UAE procedure. similar to the SE evaluation process, the TPC and AA were also assessed.

8. Microwave-Assisted Extraction:

Milestone, Italy made ETHOSTM X with dual 950 W magnetrons for a total power output of 1900 W was used to perform microwave-assisted extraction (MAE).by mixing 3 g of moringa powder with 30 ml of 70% ethanol in the high-pressure TFM (tetrafluoroethylene) microwave vessels supplied with the apparatus, biomolecules from the samples of moringa leaf were extracted. The moringa extracts were centrifuged, concentrated using a rotary vacuum evaporator (Equitron ROTEVA 66 series, Medica Instrument Mfg. Co., Mumbai), and kept at 4°C for additional analysis after being extracted with RSM generated differential runs for optimization. [22-23]

9. Supercritical extraction methods:

At the Department of Chemical Engineering Technology, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines, SC -CO2 extraction was performed in a pilot plant (built in Akico, Japan). Two methods were used to load 70 grams of the pulverized Kernels into a 500 mL extractor. The first approach involved dumping the ground kernels into the extractor in a layer that was packed randomly. The alternative procedure involved loading the ground kernels in many layers as seen in the illustration. The first two columns of Table 3 show that there were variations in the number of layers and the thickness of each layer. there were 10 mm between layers. 1b displays the pilot Plant's schematic depiction. The CO2 was first made liquid before passing to high-pressure pump (with a maximum capacity of 35 mpa) The SC-CO2's pressure and temperature were adjusted from 15 to 30 MPa and 35 to 60 °C, respectively. The SC-CO2 - oil solution and supercritical CO2 ran through the extractor. The expansion valve, where the oil and CO2 were separated, was traversed by the extractor. The oil was gathered in a container. Before being released into the atmosphere, the CO2 passed through a rotameter at a fixed rate of 0.5 m3/h (equal to 0.45 kg/h). The EtOH was introduced straight to the extractor along with the powdered kernels in the SCCO2-EtOH procedure

before extraction started, the substrate was steeped in EtOH in the actual processing environment for about 45 min. Extraction continued until no discernible change in oil output was noticed for nearly 7 h of continuous operation. In this study, the initial weight of EtOH relative to that of 500 ml CO2 at the processing Condition is used to express the percentage of EtOH.[24]

10. Maceration method:

The extraction method is used in the maceration process of 550 grams of M. oleifera leaf powder. The first step in the maceration process is the conversion of polar solvents utilising nonpolar solvents. After being coarsely chopped and allowed to air dry, the samples were macerated for three days in a row using n-hexane (7 × 2 l), ethyl acetate (8 × 2 l), and methanol (6 × 2 l). The methanol, ethyl acetate, and n-hexane fractions were produced by centrifuging each extract in a rotary evaporator. For the n hexane fraction, which had a greenish-yellow hue, each concentrated extract from the maceration was gathered and weighed in total 12.67 gm. The ethyl acetate fraction weighed 35.67 grammes [25].

11. Percolation of dried leaves (PD50 and PD70):

Separate mixtures of 50 and 70 percent ethanol (1:5, w/v) and the dried powdered leaves were combined and let to stand for an hour After that, a percolator was used to add 50 and 70 percent ethanol (resulting in a final ratio of 1:10, w/v) to the mixture. Until the percolation was finished, the extraction was carried out at room temperature with a flow rate of 1 mL/M in [21].

12. Preparation of plant decoction:

The M. oleifera leaves utilized in this study were acquired in January 2020 from Toraja, South Sulawesi, Indonesia. Prof. Gemini Alam identified the plants. Biological Laboratories at Sekolah Tinggi llmu Farmasi Makassar (2534B11) received voucher specimens for deposit. The leaves were hand harvested, ran under running water, and then drained. The samples were thermally dried for 48 hours at 40 °C in an oven from Memmert in Buchenbach, Germany, and then ground into a fine powder using a food grinder from Philips in Jakarta, Indonesia.2.5 g of the dried leaves of M. oleifera were weighed to create a decoction of M. oleifera 2.5%.and placing them in distilled water for 30 minutes, the water's temperature was held at 90°C (within 2°C).hot water was poured immediately onto the sample to make 100 mL after the mixture had been filtered under hot circumstances over a Buchner funnel. The

M. oleifera 5.0% was subjected to the same technique. just before the trial, the decoction was made in triplicate [26].

Activity of Moringa oleifera:

1. Antioxidant Activity:

Antioxidants are compounds that shield cells from free radicals, which can damage DNA and lead to the growth of cancer [27]. oxidative damage also contributes to the aging process and many chronic human diseases including cancer, diabetes mellitus, arthritis, atherosclerosis, and neurological diseases. flavonoids, phenols, tannins, and alkaloids are the main phenolic compounds in medicinal plants that are linked to antioxidant activity [28]. Epidemiological studies have demonstrated that consuming less vitamin C, an antioxidant, lowers the risk of developing coronary heart disease and cancer. Sreelatha and Padma [29] investigated the antioxidant properties of Moringa leaf extracts using conventional in vitro models, testing the extracts in both the tender and mature leaf phases. The aqueous extract of Moringa was found to have a potent scavenging effect on superoxide, nitric oxide, 2, 2diphenyl-2-picrylhydrazyl (DPPH) free radicals, and 2, 2-diphenyl- 2-picrylhydrazyl (DPPH) free radicals, as well as suppression of lipid peroxidation. Extracts of mature and Tender leaves of Moringa Oleifera have not only potent antioxidant activity not only offers strong protection against free radicals but also shields important biomolecules from oxidative damage. as a result, the antioxidant content of Moringa leaves varies depending on the stage of maturation. this was in line with earlier findings reported by Singh et al [30]. according to phytochemical screening of the hydro-ethanolic extract, the antioxidant function of Moringa may be caused by the presence of phenolic Compounds. In this regard, moringa pods contain significant amounts of bioactive substances, such as flavonoids, isothiocyanates, glucosinolates, and thiocarbamate [31]. High concentrations of tannin, phenolic compounds, and flavonoids are present in both the Moringa oleifera aqueous pod (fruit) extract (750 mg/kg) and the hydro-alcoholic leaf extracts (1000 mg/kg) contain high amounts of flavonoids, phenolic compounds, and tannin.
The plant's polyphenolic components may help explain why ethanol is used in medicine. Therefore, it can be inferred that Moringa oleifera extracts have high antioxidant activity [32] and that the presence of kaempferol in the plant's leaves demonstrated this activity, which was also noted by [33].

2. Antimicrobial Activity:

Oluduro [34] found that the Moringa leaf extract's antibacterial activity was poor because it couldn't block growth zones that were 1.5 mm in diameter, this suggests that the extract's concentration had little impact on these organisms. However, Urmi et al. [35] used the ethyl acetate fraction of the bark and fruit as well as the chloroform fraction of the leaf and fruit of the Moringa to reach a Meaningful result. According to Bako SS extracts of Salmonella typhi, Candida albicans, Staphylococcus aureus, Bacillus subtilis, and Pseudomonas aeruginosa are among the bacterial and fungal species from that Moringa growing. [36] leaves are a fantastic source of phytochemicals with antibacterial capabilities such as flavonoids and phenolic compounds. Additionally, Torres-Castillo et al [37] verified that the polyphenolic chemicals that function as antimicrobial agents have been linked to the antioxidant activities of the extracts of plant components.

3. Gastric Ulcer Protective Activity:

In two animal models of ulcers, Das et al. investigated the potential antiulcer properties of M. oleifera water extracts. In models of stomach ulcers caused by pyloric ligation and ibuprofen, the aqueous extract of the leaves was investigated for antiulcer efficacy at dose levels of 200 mg and 400 mg/kg p.o. Based on the means of the ulcer index, the degree of stomach ulceration was evaluated in both models. In the control group of animals, both models caused moderate to severe ulcers; the procedure that caused the most was pylorus ligation. when compared to the control group in both ulcer models, famotidine and the extract of M. oleifera both significantly (p 0.001) decreased the ulcer index. In the pylorus Ligation and Ibuprofen-induced ulcer techniques, M. Oleifera antiulcer impact was comparable to that of the mi medications. Gastric free acidity and total acidity were significantly (p0.05) decreased by famotidine and M. Oleifera extract. When compared to Famotidine [38], it is equally effective. Additionally, it was discovered that, in a dose-dependent manner, the aqueous extract of M. oleifera leaf prevented rats from developing stomach ulcers brought on by indomethacin. Tannins' protein-precipitating and vasoconstriction effects may be beneficial in preventing the development of ulcers [39] Because tannins are an astringent, they may have precipitated microproteins at the ulcer's site, generating an impermeable protective pellicle that shields the lining from toxins and protects it from proteolytic enzyme attack [40] By improving microcirculation and capillary resistance, flavonoids have also been found to provide some protection against the development of ulcers by making the cells less vulnerable to

aggravating stimuli [41]. It was discovered that the plant's leaf extract protected the gastric mucosa against the effects of indomethacin in a dose-dependent way. The observed benefits may be attributable to tannins and flavonoids, two phytochemical components of M. oleifera leaf extract that inhibited the development and maintenance of ulceration. Because of this, the leaf extract has the potential to be an antiulcerogenic agent, which suggests that traditional medicine uses it [42].

4.Antispasmodic, Antiulcer and Hepatoprotective activities:

It has been claimed that M. oleifera roots contain antispasmodic properties [43]. In-depth pharmacological research on moringa leaves has revealed that the ethanol extract and its constituents have antispasmodic effects that may be caused by calcium channel blockade [44-46]. Then ethanol extract of M. oleifera Leaves' activity the traditional use of leaves for treating diarrhea has been related to Additionally, the presence of 4-[-(L-rhamnosyloxy) Benzyl]- o-methyl thiocarbamate (trans) [44]. the pharmacological basis for this plant's traditional applications in gastrointestinal motility disorders is provided by the spasmolytic activity displayed by several Constituents [45]. Rats exhibited antiulcerogenic and hepatoprotective effects from the methanol fraction of the M. Oleifera Leaf extract [47]. according to [47] aqueous leaf extracts also exhibited an antiulcer activity, demonstrating the plant's widespread distribution of the antiulcer component. The hepatoprotective properties of moringa roots have also been reported additionally, it was discovered that the aqueous and alcohol extracts from Moringa blossoms had a significant hepatoprotective effect Ruckmani et al. [48], which could be attributed to quercetin, a flavonoid with a well-known hepatoprotective effect [49].

5. Antibacterial Activity:

The reason for the variation in bacterial reaction was the nature of the bacterial species, such as the Acetone extract of M. oleifera leaves, which showed antibacterial effect against both Gram-positive and Gram-negative bacteria [50]. Tanning agents and polyphenols, both of which are present in M. oleifera, are soluble in acetone and have been proven to have antibacterial properties [51] As a result, when tested in high concentrations, the Acetone extracts demonstrated bactericidal activity against E. coli. It is well known that gram-negative bacteria are typically less sensitive to the activity of plant extracts because of the cell wall's permeability barrier or the membrane accumulation mechanism [52].

6. Antimalarial Activity:

Many traditional pharmaceuticals are derived from plants. For example, the majority of the effective treatments used to treat malaria a century ago were derived from plants. such as Reserpine, salicylic acid, sennoside, Taxol, vincristine, Vinblastine, glycyrrhizin, and psoralen [53]. according to Patel et al. [54], the high amount of acetone compound in moringa makes it an effective antimalarial. However, due to the development of malarial parasite resistance, standard anti-malarial medications are rapidly losing their efficacy. However, Okechukwu et al [55] investigated the protective effects of an ethanol leaf extract of Moringa oleifera on injured liver and kidney in mice that had malaria However, Obasi and Mba,2010 [56] showed that Moringa oleifera leaf extract was effective on animals. They concluded that the extract not only protected against Plasmodium infection but also stopped the spread of new infections and stopped the disease from getting worse rats were protected from malaria (Plasmodium berghei) infection by a leaf extract from Moringa oleifera.

7. Antihypertensive Activity:

This plant is extremely beneficial in treating cardiovascular problems due to its common combination of diuretic, lipid- and blood-pressure-lowering components. Blood pressure is known to be stabilized by moringa leaf juice The Wealth of India, 1962; Dahot1988 [57] From Moringa leaves, nitrile, mustard oil glycosides, and thiocarbamate glycosides have been isolated. It was discovered that these substances were in charge of the plant's blood pressure-lowering properties [58–60]. The bulk of these substances, which contain nitrile, carbamate, or thiocarbamate groups, are entirely acetylated glycosides, which are incredibly rare in nature, according to Faizi et al. [60]. Bioassay Niazinin A, Niazinin B, Niazimicin, and Niazinin A + B were isolated as four pure components using guided fractionation of the active ethanol extract of Moringa leaves. Which revealed blood pressure-lowering Effect in rats mediated possibly through a Calcium antagonist effect [61].

8.Antitumor and Anticancer Activity:

Moringa leaves were discovered to be a possible source for antitumor activity by Makonnen et al. In [62] together with Niazimicin, 3-O-(6′-Ooleoyl- -D- glucopyranosyl), 4-(-L-rhamnosyloxy) benzyl isothiocyanate, and O-Ethyl-4-(-L-rhamnosyloxy) benzyl carbamate-β-sitosterol have been examined for their ability to promote the prevention of tumor growth utilizing an in vitro assay that revealed notable inhibitory effects on the early antigen of the

Epstein-Barr virus. Niazimicin has been proposed to be a potent chemo preventive Agent in chemical Carcinogenesis [63] The effectiveness of the seed extracts on mouse skin Papilloma genesis, antioxidant parameters, and hepatic carcinogen metabolizing enzymes has also been demonstrated [64].Neomycin and a seed ointment both effectively treated mice with staphylococcus aureus pyodermia [65] Niaziminin, a thiocarbamate contained in the leaves of M. oleifera, has been reported to prevent the activation of the Epstein-Barr virus caused by tumor promoters. However, a naturally occurring isothiocyanate, 4- [(4′-O-acetyl i-rhamnosyloxy) benzyl, significantly inhibited tumour-promoter-induced Epstein-Barr virus activation, suggesting that the isothiocyanate group is an important structural factor for activity [66].

9. Antidiabetic Activity:

It has been demonstrated that a moringa leaf extract can drop blood sugar levels within three hours of consumption, however less successfully than the go-to hypoglycaemic medication, glibenclamide.

10.Wound healing activity:

healing Properties for Wounds Excision wounds, Incision wound, and dead space wound are the three types of wounds. Were chosen to test the effectiveness of leaf ethanolic and ethyl acetate extracts as wound healers. Significant wound healing efficacy was demonstrated by ethyl acetate extracts (10% extract in the form of an ointment), which is comparable to the standard Vicco turmeric cream. these extracts contain phytosterols and phenolic substances that support the activity of the body in mending wounds.

11.Cholesterol-lowering Activity:

Because of the presence of a bioactive phytoconstituent called –Sitosterol, the crude extract of Moringa leaves significantly lowers cholesterol in the serum of rats fed a high-fat diet [67].According to Mehta et al.[68], moringa fruit can reduce blood levels of cholesterol, phospholipids, triglycerides, low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol to phospholipid ratio, atherogenic index lipid, and increase the excretion of faecal cholesterol in hypercholesteraemic rabbits.

12.In Blindness and Eye Infections:

Even though there are numerous causes of blindness, night blindness, and impaired dark adaptation are brought on by a vitamin A deficit. Consuming Moringa leaves, pods, and powder—which has a high proportion of vitamin A—can help shield kids' eyes from developing night blindness and other vision issues. Eating drumstick leaves (which contain lutein and beta-carotene) with oil improves vitamin A nutrition and may postpone the development of cataracts. Additionally, the juice can be injected into the eyes to treat conjunctivitis.

Conclusion:

Moringa oleifera Lam., an important medicinal plant, is one of the most widely cultivated species of the family Moringaceae. Pharmacologically reported effects to include anti-bacterial, antifungal, anti-inflammatory and analgesic, antioxidant, hypotensive, anti-ulcer, anaesthetic cardioprotective, antiurolithiatic activity and wound healing activity etc. This review summarizes some pharmacological activities of moringa oleifera which can be investigated further to isolate active compounds for novel herbal medicine and extraction methods. The selection of extraction methods can affect the content of bioactive compounds and their biological activities.

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