



## A review on the health benefits of *Monechma ciliatum* (Black mahlab): A potential functional food

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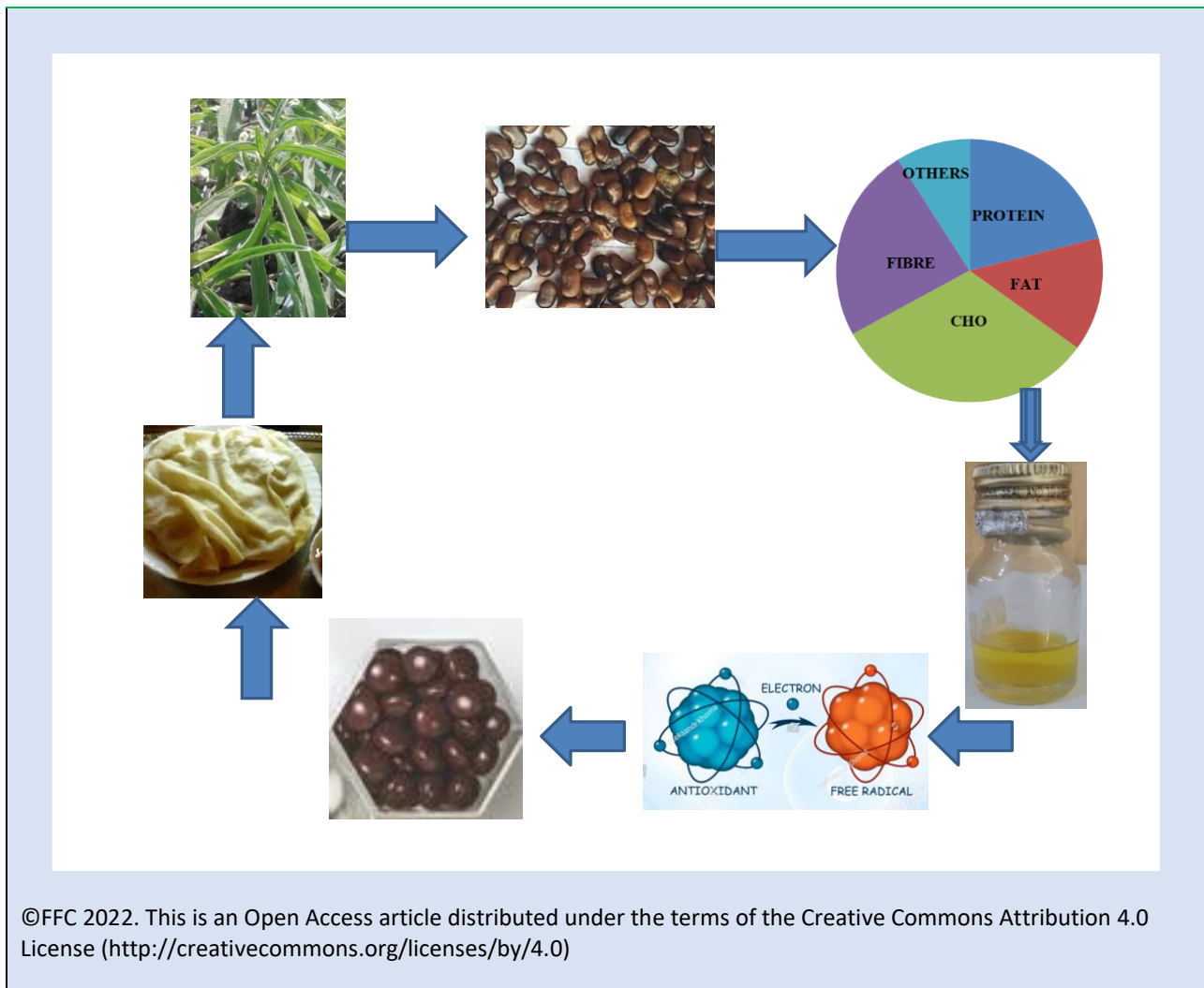
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### ABSTRACT

**Background:** *Monechma ciliatum* (MC) (Acanthaceae family) is a herb that grows in tropical and subtropical regions. It grows with small, brownish-black seeds. This is why the Sudanese people call it the “black mahlab”. This plant is primarily used in traditional meals, as well as the production of medical treatments and perfumes. Additionally, the seeds of the *Monechma ciliatum* plant are rich in fats, proteins, minerals, and other essential nutrients. It also functions as an effective laxative. As a result, this plant is commonly found as a supplement in cereal to enrich nutritional value. This review explores the nutritive value, antioxidants, antimicrobial, medicinal, cosmeceutical, and oxytocic properties of *Monechma ciliatum* seeds, leaves, and stem. To prepare this review, we researched published scientific literature by using the following keywords: “Monechma”, “Antioxidants”, “Antimicrobial”, “nutritional”, “*Monechma ciliatum*”, “Monechma phenolics”. Our search was carried out in PubMed and Google Scholar databases and included original research from the past 25 years in English only. A total number of 50 original papers, which mentioned the phytochemistry, nutritional, biological, and medicinal properties of *Monechma ciliatum* were selected and considered for this review.

**Keywords:** *Monechma ciliatum*, black mahlab, nutritional, antioxidants, Antimicrobial, oxytocic



## INTRODUCTION

Generally, plants are considered as good sources of nutrients and supplements for food, as they are important sources of many nutritive component essential for humans and animals feed [1]. Plant-based diets traditionally contain seeds as a key component, and seeds have been shown to have a variety of benefits for health. High-energy foods' replacement with seeds high in protein provides a beneficial effect on the prevention and treatment of obesity, diabetes, and the metabolic syndrome. According to an estimate, 70- 80% of rising world depends on conventional plants to obtain remedies as pharmaceuticals [2]. The Acanthaceae family is a tropical and subtropical native dicotyledonous flowering plants. This family includes about 346 genera and around 4300 species distributed in temperate regions. These plants are mostly found in Indonesia, Malaysia, Africa, Brazil, and Central America. Some spices have colorful flower petals, so

they are used as a source of natural dyes [3]. Most spices have high therapeutic applications due to their alkaloid contents [4]. Most species of Acanthaceae family harness valuable components, especially with their leaves and seeds. Studies on many species showed they are used in the treatment of bronchial diseases, relieve bites of poisonous insects, treating reptiles snake bites with and relieve dry cough, diarrhea, flu, and ulcers [5].

The genus *Monechma Hochst.*, is an African genus containing about 60 species. Most of these species are found in tropical and sub-tropical regions, specifically in Southern Africa. Generally, the *Monechma* species are described as well-adapted plants, as they can to survive in hard environments. As reported by Darbyshire and Goyder [6], twelve species are recorded in Angola, with two of them recently added to *Monechma*. The same authors reported that there are

morphological proofs that differentiate the two groups of *Monechma* in terms of shape, flowers, and fruits.

*Monechma ciliatum* (Black mahlab) is a species of *Monechma* genus to the family Acanthaceae. The plant contains unique biochemicals and phytochemical properties that make it traditionally useful for many African populations, especially in rural areas. *Monechma ciliatum* is an herb, with long leaves, smooth flowers, and seeds with thick hairs at the hilum [7]. Grazing animals can feed on *Monechma ciliatum* since it can reach 100 cm in height. Native to Africa and India, this plant has the potential to grow up to one meter high.

This plant is abundant throughout West and East Africa and is widely spread in Sudan [8]. The plant is a small herb that grows a few inches above the ground. Its leaves are simple, measuring about 4–7 x 1–2 cm [9]. In Sudan *Monechma ciliatum* (known locally as Black mahlab) is found to grow widely in Kassala State, Southern Blue Nile State, Kordofan State, Upper Nile State, Bahr Elghazal State and Bahr Eljebel. The plant is located in the west of Sudan (Jebel Marra) and southwest of Sudan in the Nuba Mountains. In Sudan, the best sowing date was reported to be in the autumn season. Plant spacing positively affects vegetative growth and yield. The wide distance between plants gave higher vegetative and reproduction growth. Successive harvesting was done before fruits reached shattering stage [7]. The seed oil composition revealed that timnodonic, oleic, and linoleic were the basic fatty acids, while the major hydrocarbon and sterol were found to be heneicosane and  $\beta$ -sitosterol [10].

In Sudan, the plant is well known and traditionally used in treatment and cosmetic, it has small, brownish black seeds, which is why the Sudanese people call it the black mahlab [11]. The species is well known and traditionally used in Kenya, where leaves are grazed by sheep and goats. Additionally, it is harvested at the end of rainy seasons and stored as hay to be used during the dry season [12]. *Monechma ciliatum* leaves were methanol extracted and administered orally to albino

rats. The daily oral administration of 100mg/kg extract did not cause lethal effects, and the study showed that the extract was not toxic to the rats. There was no evidence of toxicity [13]. This review is exploring the nutritional and antioxidant, antimicrobial, medicinal properties of *Monechma ciliatum*.

#### ***Monechma ciliatum* plantation and reproduction:**

*M.ciliatum* can be grown in any tropical and subtropical region of the world with a temperature around 25–35°C. Mohammed, and Elballa [7], studied the effect of different sowing seasons and row spacing on seed production to determine the optimum sowing date and appropriate plant spacing. They reported that autumn is a better sowing season, and wider plant spacing gave higher values for both vegetative and reproductive growth. Also early sowing date found to be an important factor of seeds oil content (which was also found to be higher in Autumn compared with Winter and Summer seasons). Plant height, number of branches per plant, number of leaves per plant, weight of fresh plants, and weight of dry plants all differed significantly across sowing days [7]. It grows in Kordofan, Darfour and Blue Nile (states of Sudan), where the dried seeds are used to prepare traditional scent, and to treat diarrhea and vomiting [14].

#### **Chemical composition and nutritional value of *M. ciliatum*:**

The cost of protein from plants is cheaper than protein from animals in developing countries. Protein content of the *M.ciliatum* seed as reported by Mariod [11] is 21% with 783.3 mg/g N, as an essential amino acids. The *M.cilliatum* seeds content of fat is 13.15%, with palmitic 4.5%, stearic 16.0%, oleic 47.3%, and linoleic 31.4%, and has a good amount of tocopherols with 45.2 mg/100g. It also contains minerals, and the total phenolic compounds of *M.ciliatum* seeds was found to be 17.1 mg GAE/g [11]. Hassan et al. [15] examined *Monechma ciliatum* leaves and concluded they contain 14% ash, 5.34% crude protein, 4.14% crude lipid, 3% crude fiber,

available carbohydrates, 73.50%, energy value 352.63(kJ/100 g DW), and a considerable amount of K, Na, Ca, Mg, Cu, Fe, Mn, and Cr as essential minerals. Leaves also contain low levels of anti-nutritional content such as oxalate, phytate, nitrite, cyanide, and tannins (which were below established toxic levels).

*M.ciliatum* seeds are rich in protein, fat, minerals, and other essential nutrients. Additionally, it has many benefits in traditional treatments [11]. Leaves are also found to be a good source of nutritive compounds and minerals [15]. Mariod, et al. [16] reported that, the predominant phenolic compounds *Monechma ciliatum* leave (MCL) extracts were *p*-coumaric acid, vanillin, and ferulic acid. They also found that MCL is a potent antioxidant for the stabilization of corn oil. Osman et al. [17]. carried out a phytochemical screening of *Monechma ciliatum* stem using petroleum ether, methanol, and aqueous extracts. These authors revealed the presence of fatty acids, volatile oils, sterols and triterpenes, basic alkaloids, carotenoids, coumarins, flavone aglycone, emodols, tannins, polyuronides, alkaloid salts, reducing compounds and saponins within the stem.

Aseel [18] investigated seeds of *Monechma ciliatum* (black mahlab) and *Prunus mahleb* (white mahlab) collected from Sudan. The materials were then analyzed using diverse chemical tests, and the oil was analyzed using various physicochemical tests according to standard procedures. The findings were then compared. This author reported higher oil content (30.9%) in white mahlab seed than 13.2%, in black seeds. The two seeds showed palmitic oleic, and linoleic acid as the predominant fatty acids but with different percentages (as black mahlab showed high amount of oleic while white mahlab showed high percentage of linoleic acid). Concerning the content of protein, the author reported white mahlab seed as higher in protein content than black mahlab seed. Many studies have been conducted to validate the traditional uses of the different parts of the plants. As *M.ciliatum* seeds are previously known as a rich source

of protein, fat, minerals and other essential nutrients, Mariod, et al. [19] conducted a study to evaluate the impact of *M. ciliatum*. The focus of this study was on these seeds as a plant –based supplement on sorghum kisra (Sudanese bread made of sorghum flour) as a stable diet for most of Sudanese population. This is in addition to the improvement on its nutritional value, The researchers investigated the effect of composite sorghum flour with untreated, boiled, roasted, and germinated *Monechma ciliatum*. Their results showed that both the supplementation of sorghum kisra with untreated and treated *Monechma ciliatum* had significantly and generally improved its nutritional value, specifically with increased fat, fiber, mineral, unsaturated fatty acids, protein, and amino acids content. Additionally, it was found that the addition of 10% *Monechma ciliatum* flour to sorghum flour made the organoleptic properties of the product acceptable. They concluded that *Monechma ciliatum* seed flour could be effective in food fortification.

#### ***Effect of processing on M. ciliatum seed composition:***

Food processing is the processing and conversion of plant or animal raw materials into products for human or animal consumption. The benefits of food processing include improvement, preservation, and protection from pathogenic microbes and toxic substances. Conversely, some plants lose their nutritive properties through processing as compared to the nutritive contents of the raw. *M. ciliatum* seeds subjected to three common processing methods by Mariod, et al. [19] these methods included boiling, roasting, and germination. Results showed significant positive effects on their nutritive contents. Most of the nutritional values of *Monechma ciliatum* (MC) were increased by processing. Specifically, all processing techniques increased the protein content, while boiling and roasting increased the fat content. Similarly, boiling and germination techniques increased the fiber content. Saturated fatty acids were increased by roasting and germination processes. Tocopherols were

increased only in the germinated sample. Amino acids composition was increased with the three processing techniques.

***M.ciliatum* as food supplement:** Much work has gone into increasing the quantity and quality of grain nutrients. These studies used different methods to improve many nutritional and health benefits associated with cereal-based foods. As *M.ciliatum* seeds previously known as a rich source of protein, fat, minerals and other essential nutrients, Mariod et al. [19] conducted a study to evaluate the impact of *M.ciliatum* as a plant –based supplement on sorghum kisra (Sudanese bread made of sorghum flour as staple diet for most of Sudanese population) and the improvement on its nutritional value, and investigated the effect of composite sorghum flour with untreated, boiled, roasted, and germinated *Monechma ciliatum*, their results showed that, the supplementation of sorghum kisra with untreated and treated *Monechma ciliatum* significantly and generally improved its nutritional value, specifically increased fat, fibre, mineral, unsaturated fatty acids, protein and amino acids. This author concluded that sorghum kisra, supplemented with 10% *Monechma ciliatum* seed flour, was found to be acceptable with respect to all sensory attributes, and it could be effective in food fortification.

***M.ciliatum* as animal feed:** Hassan et al. [15] concluded that high values of ash content of *M.ciliatum* leaves may indicate that they contain some nutritionally essential minerals that could develop growth of livestock. Mahlab leaves are used after drying and added to animal feed to compensate for the lack of mineral elements. Ogunsan [12] studied the impact of *M.cilliatum* on sheep and rabbit feed, where different ratios of *M.cilliatum* were added to the animals' daily meals. The results showed that, increasing the level of supplementation of *M.cilliatum*

beyond 20% decreased the feed intake and increased live weight of the sheep. They also found that the effect of including *M.cilliatum* in the diet of rabbits when increasing the level of supplementation of MC beyond 10% generally has the same nutritional effects on sheep without harmful effects.

**Antioxidant activity of *M.cilliatum*:** The practice of using herbs as food supplement and medicine has been accepted throughout the world. Studies concluded that consuming a variety of antioxidant compounds from natural sources can help in treating serious health disorders [11]. Various chemicals, referred to as antioxidants, incorporate properties that are extremely useful to human beings. This is because they are inclusive of decreasing loose radicals and/or reducing lipid peroxidation, which result in diverse illnesses and ageing results [20]. When consuming natural foods that contain a group of phenols, it reduces health disorders [21]. In addition to increasing nutritional quality and extending food shelf life, natural antioxidants reduce rancidity on foods and prevent toxic oxidation products from forming [22].

*M.ciliatum* has been used traditionally for treating many kinds of diseases. Studies conducted to support and prove this usage reported that *M.cilliatum* leave extract has powerful antioxidant effect due to the high content of total phenolic. Their results revealed that, *M.cilliatum* leaves extract increased the antioxidant activity of corn oil as the extract concentration was increased [23]. Hassan et al. [15] indicated that *M.ciliatum* contains significant amounts of flavonoids, phenols, alkaloids, and other metabolites. Their study also showed that the plant extracts have a promising scavenging activity in comparison to standard ascorbic acid, therefore, their study concluded that *M.ciliatum* leaves are a potential source of natural antioxidants. These results give a strong impetus to other researchers on in-depth studies in vitro and in vivo to find out the role of the bioactive ingredients responsible for these activities (in addition to

conducting studies at the molecular level) [15]. Antioxidant activity of *M.ciliatum* seed extract revealed that, the seeds phenolic rich fractions (PRFs) had the highest antioxidant activity, therefore, it reduced the oxidation of  $\beta$ -carotene by hydro peroxides from the extracts [11]. *Monechma ciliatum* is used in many African countries, including Sudan, in the treatment of many diseases such as body pain, liver disease, cold, diarrhea, and in the treatment of infertility in women. Hassan et al. [15] carried out an in-vitro antioxidant activity of *M. ciliatum* methanol, ethyl acetate and *n*-hexane leaves extract respectively. The researchers stated that *M. ciliatum* has a good radical-removing activity, which facilitates a process that can be greatly compared to standard ascorbic acid. Therefore, the possibility that the leaves are a source of natural antioxidants is very high. It is known that active plant compounds are secondary metabolites that allow plants to overcome pathological infections caused by microbes or chemical transformations of plant cells. Thus, humans can extract, purify, identify, and use them in medical treatment. The results of Hassan et al. [15] proved that methanol is the most appropriate solvent to extract these bioactive compounds.

**Anti-microbial activity of *M.ciliatum*:** Many studies have shown that traditional folk medicine uses many medicinal plants to treat skin diseases that caused by bacteria and fungi. Many Sudanese use black mahlab seed powder and its aqueous extract to treat skin problems and infections of the mucous membranes and gingivitis [11]. Traditional uses of *M. ciliatum* against microbial diseases encourage researchers to conduct experiments to prove and support these traditional beliefs by identifying the effective components and the suitable amounts and methods that should be used to obtain the benefits. Microbial activity of *Monechma ciliatum* showed a significant antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and

*Pseudomonas aeruginosa* compared with well-known antibiotics and antifungal activity against *Cladosporium cucumerinum* and *Candida albicans*. Studies on the seed's extracts, seedcakes, and leaves showed they have great contents of nutrients as antioxidant, antimicrobial, and medicinal components [23]. Pharmacologically speaking, the crude plant extracts are more active than the active isolated extracts due to the synergistic effects of the components of those extracts [24].

In a phytochemical screening conducted by Oshi and Abdelkarim [23], their result supported these traditional uses in the therapy of respiratory tract infections caused by a wide range of microbes and fungi. They found that this is due to the seed content of flavonoids, tannins, triterpens, and Quinone's. These anti-microbes affected *Staphylococcus aureus*, which was sensitive to both water and ethanol extracts. *Klebsiella pneumonia* and *Pseudomonas aeruginosa* was found to be insensitive to ethanol extract while fungi were found to be insensitive to all extracts used. The results indicated that raw *Monechma ciliatum* seed extract was tested instead of the isolated compound due to the potential for synergistic effect. Osman [17] studied the antimicrobial activity *M. ciliatum* stem using three extracts and reported that this is due to its content of many active components (fatty acids, alkaloids, essential oils, triterpenes, phytosterols and carotenoids, phenolic compounds, tannins, alkaloid salts, reducing compounds and saponins) and suggested that the most active components were found in methanolic and petroleum ether extracts [17]. Also, Abdel Karim et al. [25] examined the antimicrobial activity of the seeds oil of *M. ciliatum* and reported that it has a significant effect on *Aspergillus niger* and *Candida albicans* fungi and *Staphylococcus aureus* bacteria. The oil found to be partially active against *Escherichia coli* and *Pseudomonas aeruginosa*. However, it was found inactive against *Bacillus subtilis*. Assessment of antibacterial efficacy of different *Monechma ciliatum* leave extracts revealed that

*Staphylococcus aureus*, beta *Streptococcus haemolyticus* group A, *Pseudomonas aeruginosa* and *Escherichia coli* exhibited remarkable sensitivity to petroleum ether extract (*Proteus mirabilis* and *Klebsiella pneumoniae* to chloroform extract, and *Salmonella typhi* to methanol extract). Petroleum ether extract exhibited the highest antifungal efficiency against all tested fungal species. They attributed these different effects to the presence of phenols, sterols in petroleum ether and chloroform extracts, whereas tannins, flavonoids, coumarins, saponins and triterpenoids in methanol extract. In the same manner, Abuelgasim et al. [26] studied the antimicrobial activities of extracts of *Monechma ciliatum* stem and leaves and reported that, the concentration of the active antimicrobial constituents is different in leaves and stem of *Monechma ciliatum*. Therefore, methanolic leave extract was more effective with standard bacteria (Gram positive and Gram negative) while fungi was less sensitive to same extracts. Abdalla [27] conducted a research on *Monechma ciliatum* to know its antimicrobial activity and its pharmacological properties. He found that the chloroform extracts of the leaves had low antibacterial activity against *S. aureus*, *Bacillus subtilis*, *Candida albicans*, *Escherichia coli*, *Proteus common* and *Pseudomonas aeruginosa*. The microbial activity of the methanolic extract of Mahlab leaves was moderate against *Proteus common* and *Escherichia coli*, and low against *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. This activity was absent for *Candida albicans* and *Aspergillus niger* [27].

**Uterotonic property of *M.ciliatum*:** For a long time, plants that have the ability to contract the uterus (and are known as uterotonics) have been used to induce labor. Uterotonics are also used in abortions [28]. Uguru [29] tested the extracts of *Monechma ciliatum* leaves using different solvents for oxytocic properties of parturition for experimental mice in uterine preparations. It was found that the methanol extract

was more effective on the uterus of non-pregnant mice and guinea pig, while the uterus of pregnant rats was not affected by the extract. The study also showed that there was no abortive effect of hot methanol extract when administered orally to rats in the second week of pregnancy compared to oxytocin. However, on day 23, it was discovered that the fetus died in the womb. They also found that the extract had estrogenic activity resulting from the circumstances. In an attempt to explain the mechanism of action of the hot methanolic extract of *Monechma ciliatum* leaves, Uguru et al. [8] compared the oxytocin activity of this extract with other uterine stimulants (such as ergometrine, oxytocin, 5-hydroxytryptamine, acetylcholine, and prostaglandins) in the presence of some antibiotics. Uguru [30] purified the hot methanol extract of *Monechma ciliatum* to isolate the oxytocic principle. The polarity of the oxytocic is significant as a positive reaction with ninhydrin-spray suggests that it is an amino acid. With the addition of a bioassay and repeated column chromatography on silica gel followed by sephadex LH-20 on the rat uterus, the researchers partially identified the oxytocic principal (P3). This was suggested by previous studies as small peptide constructed of tyrosine, leucine and a third constituent to be most likely serine. To validate the traditional beliefs and uses of *M.ciliatum* to reduce pain and ease parturition, antinociceptive effect of *Monechma ciliatum* was studied by Meraiyebeu [31]. using a Von Frey's aesthesiometer. Their results showed that giving the extract both orally and intrathecally has an anti-painful effect. Additionally, it has a greater effect orally in the first quarter of an hour during intrathecal administration. Electroencephalogram (EEG) readings were also taken for all the groups. There was a decrease in amplitude and an increase in frequency for high dose (1000 mg/ml). Additionally, mid brain electrodes produced a change from theta (3.5 - 7 waves per second) to alpha waves (7.5 - 13 waves per second) (similar to that found in relaxed individuals). However, amplitude beta wave

distributions were changed and reduced, revealing similar properties for sedative hypnotic drugs.

**Medicinal uses of *M.ciliatum*:** Plants as disease treatments have been used alongside modern drugs worldwide. Every individual has used different plants as a medicinal treatment in some form. Some researchers have proven that *Monechma ciliatum* is used as a medicine for female infertility, liver disease, and diarrhea [32]. Residents of the Sudanese Nuba Mountains use black mahlab seeds to treat asthma and colds. They also use it as an anthelmintic and anti-dysentery [13]. As in Botswana, black mahlab is used as a pain reliever and treatment for various kidney and liver diseases [32]. Malaria is one of the most common health problems all over the world, so Shayoub [33] studied and evaluated the extract of *M. ciliatum* and its efficacy as an antimalarial *Plasmodium falciparum*. The extracts were studied with several different solvents. These solvents had variable concentrations of 125, 250 and 500 µg/ml. The results showed that extracts of *M. ciliatum* have strong antimalarial activities.

Another study on medicinal use of *M. ciliatum* was carried out by Mariod, et al. [34] on the effects of *M. ciliatum* methanolic extract (MCME) on low density lipoprotein receptor (LDLR). They concluded that MCME concentration played a major role, and different doses showed significant differences in regulation of both LDLR and 3-Hydroxy-3-Methylglutaryl-CoA Reductase (HMGCR) genes. The results showed that the methanolic extract of black mahlab regulates LDLR and HMGCR genes that significantly affect cholesterol metabolism in HepG2 cells. According to the African traditional medicinal uses, *Monechma ciliatum* seed powder soaked in water and drunk or burnt can act as an inhalation for cold and allergic condition treatment. To validate these traditional beliefs, Oshi and Abdelkareem [23] formulated and studied a conventional dosage form (tablets) from *Monechma ciliatum* seed's ethanolic extract using the wet

granulation method. Two formulations were prepared, the first using starch as a binder and disintegrant, and the second using polyvinylpyrrolidone and cross-linked cellulose with carmellose as a binder and disintegrant.

They conducted a study using oleic acid, coumarin, 1,2-dioleoylglycerol, and 1,3-dioleoylglycerol isolated from water extract of *M. ciliatum* seeds. This was to observe these components activity of *P. gingivalis*. Their results validated the application of using *M. ciliatum* as an effective therapeutic agent to prevent periodontal diseases [35].

#### **Anticancer activity**

Essential oils contain many effective compounds that are useful in treating cancer [36]. Cereals, vegetables, and fruits contain phenols and flavonoids (which are very important and effective plant compounds). These secondary metabolites are natural antioxidants that protect the body from cardiovascular disease, aging, and cancer (based on their multiple biological effects) [37].

**Cosmetical uses of *M.ciliatum* seeds:** Based on what is found in literature of traditional medicine, medicinal herbs have been used throughout the ages in cosmetic operations. Herbal extracts have been utilized for different skin and hair diseases. Market research reports increasing demand in the herbal and cosmetic industry, therefore playing a major role in fueling this worldwide demand. The recent interest of consumers in herbal cosmetics has been attribute to declining faith in modern chemical cosmetics.

Sudanese women use the seeds of black mahlab in the preparation of cosmetics and perfumes that are used in marriage and childbirth rituals [11]. It is one of the useful odor plants in nomadic area of Western Sudan. Oshi, et al. [16] conducted a study to validate the claim of inhalation of *Monechma ciliatum* seeds powder from traditional African natives and Sudanese people in Nubia Mountains regions. The researchers



concluded that the traditional uses of *M.ciliatum* seeds for cosmetics purposes referred to antioxidant activity of flavonoids and tannins. These components are considered as effective substitutes to limiting the damage caused by free radicals of skin. The triterpenes and sterols are aromatic constituents of medicinal plants. The high antibacterial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Escherichia coli*, *Candida albicans* and *Aspergillus niger* of black mahlab seeds provides scientific evidence for the traditional uses of black mahlab seeds as a cosmetical treatment for skin and mucous membrane disorders [16].

## CONCLUSION

It is clear that the seeds of *M.ciliatum* possess many benefits. For example, they contain valuable sources of human nutrients. Additionally, the leaves are good for animal feed. Most parts of the plant also have great antioxidant, anti-microbial, and cosmetic properties. Further work on these properties is needed to corroborate the primary mechanisms as antioxidants and antimicrobial agents. The plant could become a valuable source of income if commercially exploited by food and medical researchers and industries. Table 1 summarizes some of the findings in this review article.

**Table 1.** Some investigated biological activities, chemical and phytochemical composition of *Monechma ciliatum*

Biological activities	Plant part and extracting solvent	Source
Antioxidant activity	Anti-microbial activity	23, 15
Antioxidant activity	Seed	11,15
Anti-microbial activity	Seed	11, 23, 24
Anti-microbial activity	Stem	17, 26
Anti-microbial activity	Seed's oil	25
Anti-microbial activity	Leaves	26, 27
Uterotonic property	Leaves	8, 28, 29, 30
Anthelmintic and anti-dysentery	The whole plant	13, 32
Antimalarial activity	The whole plant	33
Regulation of genes	Seedcake	34
Anticancer activity	Essential oil	36, 37
Cosmetical uses	Seed	11, 16
Chemical and phytochemical composition		
Plant part	Composition	Source
Seed	Protein, carbohydrates, lipid, fiber, minerals, amino acids,	11,18, 19
Leaves	Ash, crude protein, crude lipid, crude fiber, carbohydrate, minerals (K, Na, Ca, Mg, Cu, Fe, Mn, and Cr), phenolic compounds ( <i>p</i> -coumaric acid, vanillin and ferulic)	12, 15, 16, 23
Stem	Fatty acids, volatile oils, sterols and triterpenes, basic alkaloids, carotenoids, coumarins, flavone aglycone, emodols, tannins, polyuronides, alkaloid salts, reducing compounds and saponins	17
Seed oil	Fatty acids, palmitic, stearic, oleic, linoleic, tocopherols	11, 25

**List of Abbreviations** EEG: Electroencephalogram, HMGR: 3-Hydroxy-3-Methylglutaryl-CoA Reductase, LDLR: Low density lipoprotein receptor, MC: *Monechma ciliatum*, MCL: *Monechma ciliatum* leave, MCME: *M. cilliattm* methanolic extract, PRFs: Phenolic rich fractions

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**Authors' Contributions:** Mariod had the original concept for the presented idea, and Mustafa and Yahia wrote the manuscript draft with support from Mariod. All of the authors discussed the reviewed results and contributed to the final manuscript. All authors also contributed to the final version of the review manuscript.

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