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Review on biological and immunomodulatory properties of *Moringa oleifera* in animal and human nutrition

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***Moringa oleifera*, also called "miracle tree" or "tree for life" is a tree native from India. Highly resistant to drought, *M. oleifera* grows very well in tropical regions, including Benin. It is a plant with very high nutritional values. The different parts of the plant (leaves, fruiots, seeds, roots, bark and flowers) have multiple uses, both therapeutic and nutritional, with uses in human and animals. The leaves for example, are rich in minerals, vitamins, phenolic compounds like phenolic acids, tannins, flavonoids, phytosterols, and alkaloids. It is reported that *M. oleifera* had anaphylactic, antiulcer, hepatoprotective, anti-inflammatory, antitumor and anticancer, antioxidant, antidiabetic and antimicrobial properties. The present study focuses on the biological properties of *Moringa* so that it can be used in the treatment of viral diseases in chicken.**

Key words: *Moringa oleifera*, bioactive compounds, biological properties.

INTRODUCTION

Moringa oleifera, also called "miracle tree" or "tree of life" (Fuglie, 2002) is a tree native from India. Drought tolerant (Bosch, 2017), *M. oleifera* is a widely available plant in tropical and subtropical countries with great economic importance (Foidl et al., 2001). It is a plant with very high nutritional values. This is for a tree, all over the tree, can be self-food, old food and industrial (Khalafalla et al., 2010). *M. oleifera* is described as a natural anthelmintic, a mild antibiotic, a detoxifier, an exceptional immune builder. It is used in many countries to treat malnutrition and malaria (Khesorn, 2009) and according to Dhakad et al. (2019) *M. oleifera* is the most inexpensive and credible alternative to provide good nutrition and curing and prevention of several disorders. In recent decades, there has been a growing interest in the study of medicinal plants and their traditional use in different parts of the world. However, there is very little information on the use of *M. oleifera* leaves as an immunomodulator, and on reducing the mortality rate in chickens infected with Newcastle virus (Eze et al., 2013).

The purpose of this document is to provide a bibliographic overview of the properties of M. oleifera, which is the first step in evaluating the immune-enhancing properties of this plant in chickens with

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a-Leaves **(Price, 2007)**

b- Flowers **(de Saint Sauveur et Broin, 2010)**

c- Pods and seeds **(Atakpama *et al*., 2014)**

Figure 1. Monogeneric family of shrubs and trees of Moringaceae.

Newcastle disease. Indeed, various authors have reported anaphylactic, antiulcer, antithyroid, hepatoprotective, anti-inflammatory, antidiabetic, antihyperglycemic, anti-tumor, anti-cancer, anti-oxidant, antiperoxidative, diuretic, antiurolithiatic, hypocholesterolemic, antihypertensive, cardioprotective, antiasthmatic, immunomodulatory properties of *Moringa oleifera*.

Botanical description, geographic distribution and chemical composition of *M. oleifera*

M. oleifera Lam. or *Moringa* pterygosperma Gaertner is a shrub belonging to the family *Moringa*ceae, cultivated for its leaves, flowers and fruits with many nutritional, medicinal and industrial potentialities. This tree, native to India, has been introduced in all tropical and subtropical regions (Price, 2007; Atakpama et al., 2014) and has become naturalized in many African countries. Still called mouroungue, ben ailé, neverdié, horseradish tree; *M. oleifera* is a small, fast-growing, perennial (Bosch, 2017) deciduous tree that can reach 7 to 12 m in height (Foidl et al., 2001).

The stem is brittle with a cork bark, whitish gray, with drooping branches; the leaves are pale green and bipinnate or more often tripinnate with opposite and ovoid leaves (Pandey et al., 2011). They are 6.5 to 60 cm long, 4 to 6 pairs of pinnae and elliptic to Tableobovate leaflets (Bosch, 2017) (Figure 1a). The fragrant, bisexual and zygomorphous flowers have five free petals, oblong-spatulate, 1 to 2 cm long, unequal, white or cream and finely veined (Figure 1b). The fruit of *Moringa oleifera* is a pendulous and elongated capsule, 10 to 50 cm long, brown in color becoming dark brown when ripe (Bosch, 2017). The fruits form pods with three lobes which, when dry, open in three parts (Figure 1c). Each pod contains between 12 and 35 seeds (Foidl et al., 2001). Seeds, globose, 1 to 1.5 cm in diameter bear three thin wings (Bosch, 2017).

M. oleifera Lam. belongs to the monogeneric family of shrubs and trees of *Moringa*ceae which includes about 13 species. The other twelve species are well known. They are *M. arborea, M. borziana, M. concanensis, M. drouhardii, M. hildebrandtii, M. longituba, M. ovalifolia, M. peregrina, M. pygmaea, M. rivae, M. ruspoliana, M. stenopetala*. *M. oleifera* Lam. is the most widely known and used species (Foidl et al., 2001; Fuglie, 2002).

M. oleifera is growing well at low altitudes (Bosch, 2017). Indeed, it prefers an altitude lower than 600 m (Price, 2007). In East Africa, it is found up to 1350 m altitude, but in Zimbabwe, a naturalized stand at 2000 m testifies to its adaptability (Bosch, 2017). Drought-tolerant, it tolerates a wide range of cprecipitation with minimum precipitation requirements estimated at 250 mm and maximum at more than 3000 mm and a pH of 5.0 - 9.0 (Palada and Changl, 2003). It can be grown in all kinds of soils, but it is mostly fertile and well-drained soils that suit it. Slight frosts are tolerated (Bosch, 2017).

Propagation of *M. oleifera* is by seed (sown directly in the field at the beginning of the rainy season, either in nursery watered during the dry season), or by cuttings (Bosch, 2017). The results of the screening of *M. oleifera* leaves show that the leaves of this tree are rich in sterols and triterpenes (terpenoids), carotenoids, essential amino acids, flavonoids, tannins, sugars and fibers. Coumarin derivatives and alkaloids are in trace amounts (Millogo-Koné et al., 2012). Cardiac glycosides, saponins and ascorbic acid have been identified in the leaves of *Moringa oleifera* (Okumu et al., 2016). In addition, the leaves of *M. oleifera* contain a very high concentration of vitamins (A, B, C, E, etc.), proteins, certain minerals (iron, calcium, zinc, selenium, etc.) and a rather rare phenomenon. For a plant, it has the amino acids and essential fatty acids (Broin, 2005; Fuglie, 2002; Kasolo et al., 2010; Nouman et al., 2013; De Saint Sauveur and Broin, 2010). They provide a rich and rare combinat ion of zeatin, quercetin, caffeoylquinic acid, beta-sitosterol and kaempferol (Moyo et al., 2011). Studies have shown that mature leaves of *M. oleifera* contain less protein than young leaves because of their high fiber content, including crude fiber ranging from 9.13 to 28.2% of dry matter (Richter et al., 2003; Ndong et al., 2007).

Table 1. Average composition of some parts of *M. oleifera*.

Variable	Fresh leaves	Powder leaves	Pods
Humidity (%)	75.0	7.5	86.9
Calories (kcal)	92.0	205.0	26.0
Protein (g)	6.7	27.1	2.5
Lipid (g)	1.7	2.3	0.1
Carbohydrate (g)	13.4	38.2	3.7
Fibers (g)	0.9	19.2	4.8
Ca (mg)	440.0	2.003	30.0
Mg (mg)	24.0	368.0	24.0
P (mg)	70.0	204.0	110.0
K (mg)	259.0	1.324	259.0
Cu (mg)	1.1	0.57	3.1
Fe (mg)	7.0	28.2	5.3
S (mg)	137.0	870.0	137.0
Oxalic acid (mg)	101.0	1.6%	10.0
Vitamin A - ß-carotène (mg)	6.8	16.3	0.11
Vitamin B -choline (mg)	423.0	-	423.0
Vitamin B1 -thiamine (mg)	0.21	2.64	0.05
Vitamin B2 -riboflavin (mg)	0.05	20.5	0.07
Vitamin B3 - nicotinic acid (mg)	0.8	8.2	0.2
Vitamin C - ascorbic acid (mg)	220.0	17.3	120.0
Vitamin E -tocopherol acetate (mg)	-	113.0	-
Arginine (g/16g N)	6.0	1.33%	3.6
Histidine (g/16g N)	2.1	0.61%	1.1
Lysine (g/16g N)	4.3	1.32%	1.5
Tryptophane (g/16g N)	1.9	0.43%	0.8
Phénylanaline (g/16g N)	6.4	1.39%	4.3
Méthionine (g/16g N)	2.0	0.35%	1.4
Thréonine (g/16g N)	4.9	1.19%	3.9
Leucine (g/16g N)	9.3	1.95%	6.5
Isoleucine (g/16g N)	6.3	0.83%	4.4
Valine (g/16g N)	7.1	1.06%	5.4

Source: Fuglie (2005).

Sterols, glycosides, alkaloids, triterpenoids, flavonoids, anthraquinones, carotenoids and tannins have been identified in the stem bark and flowers of *M. oleifera*. The seeds are oleaginous, revealing a very high fatty acid profile. They have the same health benefits as olive oil (Anwar et al., 2007). The leaves of *M. oleifera* contain negligible proportions of anti-nutritional factors (Kavitha et al., 2012). The average composition of some parts of *M. oleifera* is established in Table 1.

MATERIALS AND METHODS

The review article was written using secondary data analysis. Information on searching databases such as Agora, Hinari, Google Scholar, various journals, books, articles were used during redaction of biological properties and immunomodulatory effect of *M. oleifera* in animal and human nutrition.

RESULTS AND DISCUSSION

Biological activities of *M. oleifera*

Anti-anaphylactic activity

The anti-anaphylactic effect of the ethanolic seed extract was studied in a murine model of systemic anaphylactic shock induced by compound 48/80. Passive cutaneous anaphylaxis activated by the anti-IgE antibody was also used to evaluate the effect of the extract (Mahajan and Mehta, 2007). The study showed, on the one hand, that administered one hour before the injection of compound 48/80, the ethanolic extract of *M. oleifera* at doses of 0.001 to 1 g / kg completely inhibits the induced anaphylactic shock; on the other hand, the extract significantly inhibits the passive cutaneous anaphylaxis

activated by the anti-IgE antibody at a dose of 1 g / kg (Mahajan and Mehta, 2007).

Antiulcer activity

The root extract of *M. oleifera* have been used in the treatment of ulcerative colitis in mice (Gholap et al., 2012). Leaf extracts also produced a significant reduction in stress-induced gastric ulcers and duodenal ulcers induced by cysteamine (Devaraj et al., 2007). Debnath and Guha (2007) also reported an anti-ulcer effect of the aqueous extract of *M. oleifera* leaves on adult albino Holtzman rats. Indeed, according to these authors, treatment with *M. oleifera* for 14 days on ulcerated rats decreased the average ulcer index, increased the number of enterochromaffin cells and the content of 5-hydroxytryptamine. The alcoholic leaves extract of *M. oleifera* Lam. has shown ulcer protective effect as dose dependently against pylorus-ligation, ethanol, cold restraint stress, and aspirin induced gastric ulcer in rats. The said extract of *M. oleifera* Lam. was found to decrease ulcer and acid pepsin secretion (Verma et al., 2012).

Antithyroid activity

Tahiliani and Kar (2000) studied the role of *M. oleifera* leaf extract in the regulation of thyroid hormones in Swiss adult rats and found that it plays an inhibitory role in the peripheral conversion of tetraidothyoronin (T4) into triiodothyronine (T3). In addition, at low concentrations, this extract can be used to control hyperthyroidism (Tahiliani and Kar, 2000).

Hepatoprotective activity

Various studies have reported that ethanolic extracts of seeds and leaves of *M. oleifera* have hepatoprotective action. Indeed, Pari and Kumar (2002) evaluated the hepatoprotective effect of the ethanolic extract of *M. oleifera* leaves on hepatic lesions induced by antituberculous drugs such as isoniazid, rifampicin and pyrazinamide in rats. Thus, oral administration of the extract has shown an important protective action made evident by its effect on the levels of alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase and bilirubin in serum, also on lipid levels and lipid peroxidation in the liver. This observation was completed by a histopathological examination of the liver.

The seed extract of *M. oleifera* also exerts a hepatoprotective effect against liver fibrosis induced by the oral administration of 20% carbon tetrachloride (CCl4). Indeed, the administration of *Moringa* seed extract decreased the CCl_4-induced elevation of serum aminotransferase activity and the level of globulin (Hamza, 2010).

Anti-inflammatory activity

Several parts of the *Moringa* plant have shown anti-inflammatory activity. The anti-inflammatory activity of the methanolic extract of *M. oleifera* leaves has been demonstrated using tests induced by carrageenan and histamine (Adepapo et al., 2014). N'diaye et al. (2002) showed that *M. oleifera* root extract has anti-inflammatory activity in carrageenan-induced paw edema in rats using indomethacin, a potent anti-inflammatory drug (10 mg / kg). In fact, at a dose of 750 mg / kg, the aqueous root extract of *M. oleifera* significantly inhibited the development of edema at 1, 3 and 5 hours (53.5, 44.6 and 51.1% respectively).

Alcohol extract from *M. oleifera* seeds has also shown anti-inflammatory activity against ovalbumin-induced respiratory tract inflammation in guinea pigs (Mahajan and Mehta, 2007). Bioactive compounds in *M. oleifera* pods can contribute to anti-inflammatory activity to improve the pathogenesis of chronic inflammatory diseases (Muangnoi et al., 2012).

Antidiabetic activities

The use of *M. oleifera* as a therapeutic agent against diabetes has been explored. Studies have shown that in rats with type 2 diabetes, leaves of *M. oleifera* significantly reduce glucose concentration. Leaves are indeed a powerful source of polyphenols, responsible for hypoglycemic activity. *M. oleifera* also has an enhancing effect on glucose intolerance that can be mediated by quercetin-3-glucoside and fibers contained in leaf powder (Ndong et al., 2007). The aqueous extract of *M. oleifera* leaves at doses of 100, 200 and 300 mg / kg body weight showed a reduction of 33.29; 40.69 and 44.06% of the glycemia of alloxan-induced diabetic albino rats (Edoga et al., 2013). At the same doses, Manohar et al. (2012) showed the antihyperglycaemic activity of the aqueous extract of *M. oleifera* leaves on normal rabbits and diabetic alloxan-induced rabbits. *Moringa* fruit lower serum cholesterol, phospholipids, triglycerides, LDL (Low Density Lipoprotein), VLDL (Very Low Density Lipoprotein) and reduce lipid profile in cholesterol-positive rabbits elevated and then increase the excretion of fecal cholesterol (Mehta et al., 2003).

Antitumor activities

M. oleifera has several bioactive compounds with antitumor activity. Niazimicin, niaziminine and beta-sitosterol-3-o-beta-D-glucopyranoside have indeed shown

an antitumor action. Studies have explored the chemopreventive and antiproliferative potential of *M. oleifera* against chemical carcinogenesis, as well as its role in epithelial ovarian cancer. In addition, *M. oleifera* seed extracts have effects on enzymes metabolizing hepatic carcinogen (Bharali et al., 2003; Bose, 2007). The leaf extract of *M. oleifera* has shown potential cytotoxic effects on cell lines of human multiple myeloma (Parvathy and Umamaheshwari, 2007; Soha et al., 2019).

Antioxidant activities

Exploration of *M. oleifera* as a potential source of antioxidants has yielded positive results (Chumark et al., 2008). The content of phenolic compounds present in the leaves confers a scavenging property of free radicals, whereas the ethanolic fraction has considerable properties of metal chelation which can protect against DNA cleavage (Verma et al., 2009; Sreelatha and Padma, 2009; Singh et al., 2009). Seed powder showed a reduction in tissue arsenic concentration, providing protection against oxidative stress (Gupta et al., 2007). *M. oleifera* seeds have been shown to be superior for trapping free radicals relative to palm oil (Ogbunugafor et al., 2011). Aqueous-methanol extract of *M. oleifera* leaves has antioxidant capacity (Okumu et al., 2016).

Diuretic and antiurolithic activities

Studies indicate that the *M. oleifera* wood root has anti-urolithic activity (Dubey et al., 2013). One study also revealed an anti-lithiolithic property of the aqueous and alcoholic extracts of the bark of the *M. oleifera* root (Karadi et al., 2006). Indeed, both extracts significantly lowered the levels of urinary excretion and renal retention of oxalate, calcium and phosphate.

Hypocholesterolemic and cardioprotective activities

The *Moringa* root bark contains the moringinine alkaloid, which by its effect on the sympathetic nervous system stimulates cardiac function (Duke, 2001). The effects may also be due to the prevention of hyperlipidemia. He demonstrated that *M. oleifera* prevents hyperlipidemia due to iron deficiency in male Wistar rats (Ndong et al., 2007). A study comparing *M. oleifera* leaf extract with antenolol (a selective β1-receptor antagonist used for cardiovascular diseases) reported the leaf extract of *M. oleifera* as a hypolipidemic, lowering of body weight, heart weight, serum triglyceride and cholesterol levels in experimental animals (Ara et al., 2008).

M. oleifera also has a cardioprotective role in isoproterenol-induced myocardial infarction. Treatment with *M. oleifera* has been reported to have cardioprotective cardioprotective effects in male Wistar albino rats on enzymatic biochemical parameters including superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase, and creatine kinase (Farooq et al., 2012). It has also been shown that this compound lowers cholesterol levels in rats fed a high-fat diet (Ghasi et al., 2000).

Antihypertensive activities

Several bioactive compounds in *M. oleifera* leaves exert a direct effect on blood pressure and can thus be used for the stabilization of blood pressure. The compounds of *M. oleifera* leading to an antihypertensive effect include nitrile, mustard oil glycosides and thiocarbamate glycosides present in *Moringa* leaves (Anwar et al., 2007). *Moringa* leaves contain β-sitosterol, a bioactive phytoconstituent with a cholesterol lowering effect.

Antiasthmatic activity

The alkaloid of the *Moringa* plant showed a similarity with ephedrine in terms of activity. Thus, it can be used in the treatment of asthma. The seeds of *M. oleifera* have shown a potential effect in the management of bronchial asthma. Patients showed significant relief from the severity of asthma symptoms in addition to improved respiratory function (Agarwal and Mehta, 2008).

Immunomodulatory activity

The immunomodulatory action of the methanolic extract of *M. oleifera* was studied in an experimental model of immunity. Neutrophil adhesion assays, cyclophosphamide-induced neutropenia, and carbon clearance assay were used to study cellular immunity. Humoral immunity was tested by lethality testing in mice, estimation of serum immunoglobulin levels, and indirect haemagglutination assay in animals. The study showed that *M. oleifera* stimulates both the cell-mediated and the humoral-mediated immune system at lower doses (Sudha et al., 2010). Several studies concluded that, the inclusion of *M. oleifera* in chicken diets resulted in better growth performance, immune response and antioxidative status (Khan et al., 2017; Oghenebrorhie and Oghenesuvwe, 2016; Yeung et al., 2019). Cui et al. (2018) reported that dietary *M. Oleifera* supplementation can act as ROS scavenger to improve the antioxidant capacity by activating the antioxidant enzymes and reducing the level of oxidative enzymes in broilers. Moussa et al. (2017) have reported that the inclusion of dietary *M. Oleifera* could improve the immune response of chickens. Furthermore, El-Deep et al. (2019) reported that *M. oleifera* supplementation of broiler's diet would

also modulate the immune response by regulating mRNA expression levels of the innate immune response mediators, such as IL2 and IL6, and alleviating the degenerative changes that occurred in live tissue following HS.

Spasmolytic activity

The roots as well as the ethanol extract of the leaves showed an antispasmodic action, perhaps through the blocking of calcium channels. The spasmolytic activity exhibited by the constituents of the plant provides a solid base for traditional uses of the plant in gastrointestinal motility disorders (Anwar et al., 1994).

Radioprotective activity

A radioprotective effect was observed in the methanolic extract of *M. oleifera* leaves in irradiated Swiss albino mice. In fact, pretreatment with the methanolic extract of *M. oleifera* leaves considerably reduces the percentage of aberrant cells in the bone marrow after irradiation with gamma whole body radiation in animals. Pretreatment with the methanolic extract of *M. oleifera* leaves confers significant radiative protection to bone marrow chromosomes in irradiated mice (Rao et al., 2001).

Antinociceptive activity

Several studies have shown that *M. oleifera* has analgesic activity. This activity was indeed demonstrated using the acetic acid induced convulsion test and the Eddy hot plate test for peripheral and central analgesic actions respectively using albino mice. The ethanolic leaf extract of *M. oleifera* showed significant analgesic activity at 100, 200, 400 mg / kg in both tests compared to the control group (Bhattacharya et al., 2014).

The antimigraine potential of the alcoholic fraction of leaf sap of *M. oleifera* that is traditionally used in the treatment of migraine has been studied. The study showed that *Moringa* can be used effectively in the treatment and management of migraine (Upadhye et al., 2012). The fresh leaf sap and ethanol extract of *Moringa oleifera* leaves were administered orally at varying doses to mice and were tested for antinociceptive activities using three models: acetic acid-induced convulsion, licking of the formalin-induced paw and tail stroke test using analgesiometer. The study showed significant antinociceptive activity of *M. oleifera* (Upadhye et al., 2011).

Healing activity

The aqueous extract of *M. oleifera* leaves and the ethyl acetate extract of dried leaves were found to have significant healing potential. For the study, 10% of the extract was applied to excision, incision and dead space (granuloma) models in the rat as an ointment (Rathi et al., 2006; Hukkeri et al., 2006). The polysterols and phenolic compounds in these extracts promote healing activity (Dubey et al., 2013).

Antimicrobial activities and antihelminthic effects

Various components of *M. oleifera* have inhibitory activity against several microorganisms. The seeds of *M. oleifera* because of some active ingredients they contain: antimicrobial isothiocyanates and glucomoringin is a potent antibacterial and antifungal agent (Padla et al., 2012; Galuppo et al., 2013; Jeon et al., 2014). Moreover Dougnon et al. (2011) have shown that the ethanolic extract of *M. oleifera* leaves has antibacterial activity against *Staphylococcus aureus* strains.

A range of antimicrobial activity has been observed from susceptibility of *B. stearothermophilus* to resistance to *Pseudomonas aeruginosa* (Ali et al., 2004). In addition to the antibacterial activity of *M. oleifera* oils, antifungal activity has also been demonstrated (Chuang et al., 2007). Comparative comparison of the antibacterial and antifungal efficacy of the *M. oleifera* vapor distillate revealed maximal inhibition of *E. coli* followed by *S. aureus, Klebsiella pneumoniae, P. aeruginosa* and *Bacillus subtilis*. Of the fungi, *Aspergillus niger* was the most inhibited, followed by *Aspergillus oryzae, Aspergillus terreus* and *Aspergillus nidulans* (Prashith et al., 2010).

Alcohol extracts from leaves, seeds and flowers showed antimicrobial activity against *E. coli*, *Klebsiella pneumoniae, Enterobacter* species*, Proteus mirabilis, P. aeruginosa, Salmonella typhi, Streptococcus aureus,* and *Candida albicans* (Nepolean et al., 2009). *In vitro* antifungal activity has been observed against dermatophytes such as *Trichophyton rubrum, Trichophyton mentagrophytes, Epidermophyton floccosum* and *Microsporum canis*, including some species of *Aspergillus* and *Penicillium* (Ayanbimpe et al., 2009).

Recent discoveries have revealed cyanobactericidal potential in seeds (Lürling and Beekman, 2010). It has also been reported that ethanolic extracts of *M. oleifera* leaves inhibit the Indian worm Pheritima posthuma (Rastogi et al., 2009).

Antiplasmodial activity

In vitro studies have shown an antiprotozoal effect of *M.oleifera* (Köhler et al., 2002). Soluble seed extract lectin showed larvicidal activity by delaying larval development and promoting mortality in Aedes aegypti, probably due to its haemagglutinating activity (Coelho et al., 2009; Ferreira et al., 2009).

Cerebroprotective and depressive activities of the Central Nervous System (CNS)

The root extract exhibits CNS depressive activity. Studies using the aqueous extract of *M. oleifera* root on penicillin-induced convulsion, locomotor behavior, cerebral serotonin (5-HT), dopamine (DA) and norepineprine (NE) were studied in rat. The extract improved the imbalance between 5-HT, DA and NE (Ray et al., 2003). The brain-protective effect of *M. oleifera* leaf extract against brain damage and oxidative stress in the animal model of focal ischemic stroke was studied. The study demonstrated that *M. oleifera* leaf extract is a potential neuroprotectant that is cheap and easy to approach (Kirisattayakul et al., 2013).

Other pharmacological effects of *M. oleifera*

Work on the leaves of *M. oleifera* has shown that they can serve as a strengthening of the immune system against viral damage and especially in people living with HIV / AIDS (Lipipun et al., 2003). Flowers and leaves are used to treat inflammation, muscle disease, hysteria, tumors, enlarged spleen, and reduced serum cholesterol (Siddhuraju and Becker, 2003).

Conclusion

The different researches on *M. oleifera* have come to justify the various uses and virtues that endogenous populations have lent to it for centuries. Given the different nutrients and properties of this miracle tree, it would benefit from being considered in the efforts to contain cases of bacterial resistance increasingly frequent and why not in the prevention and fight against avian pathologies of origin viral disease like Newcastle disease. Also, several investigations are needed to corroborate the main mechanisms of *Moringa* as an immunostimulatory agent.

CONFLICT OF INTEREST

The authors have not declared any conflict of interests.

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