Moringa oleifera: a new perspective for the synthesis of natural products

Kamila Bezerra 1; Nathália Galvão Silva 2*; Aleson de Souza 3; Giulian Sá 3 and Francielly de Araújo 3.

1 Graduate’s in Biological Sciences Federal University of Paraiba - UFPB; E-Mails: kamiilasantoss13@gmail.com
2 Biologist, Master’s in Biological Sciences, Federal University of Pernambuco – UFPE; E-Mail: nathaliargalvao@gmail.com;
3 Biologist, Master in Cellular and Molecular Biology Federal University of Paraiba - UFPB; E-Mails: aleson_155@hotmail.com/giuliancesarsa@gmail.com/franciellyng@hotmail.com.

* Author to whom correspondence should be addressed; E-Mail: nathaliargalvao@gmail.com;
Tel.: +55-83-99930-2929

Received: / Accepted: / Published:

Abstract: Moringa oleifera Lam. is a plant native from India, but its distribution extends to all continents. Its leaves, flowers, pods and seeds are commonly used for food, mainly in Africa, due to its high nutritional value. With regard to medicine, M. oleifera demonstrates immeasurable potential in view of the various biological activities which are reported from its secondary compounds, such as alkaloids, tannins, flavonols, steroids, saponins, coumarins, quinones, resins, lectins among others. Based on this assumption, this review aims to expose the potential of Moringa oleifera in the period 2016-2018, in the use of its compounds for the synthesis of natural products due to its diverse biological activities. The results showed that the several parts of the plant may have different biological activities. The seeds have antibacterial activity with dental importance; activity in the prevention and deceleration of the amyotrophic lateral sclerosis disease (ALS); anti-hypertrophic and anti-fibrotic effect, being beneficial for cardiac structure and function in hypertensive mice; anticancer activity; anti-inflammatory; and protection of neural cells. For the leaves were reported Antitumor activities; therapeutic efficacy against neurotoxicity; for insulin expression and decrease in the degree of insulitis; antimicrobial activity; reduction of myocardial damage and oxidative stress; treatment in atopic dermatitis; gastroprotective activity and improvement of mucus; hypocholesterolemic effect; and ability to prevent chromatolysis, distortion of cerebellar cortical cells and neurobehavioral deficit. For the other parts of the plant similar activities are described, however in less quantity. Thus, Moringa oleifera presents a new perspective on the synthesis of natural products, considering the range of biological activities described for a species, as well as the ease of obtaining and using its compounds.
Keywords: Biological activity; moringa; secondary compounds.

Mol2Net YouTube channel: http://bit.do/mol2nettube

1. Introduction

*Moringa oleifera* Lam. is a species of plant belonging to the family Moringaceae, being native to Asia, but cultivated in tropical and subtropical regions around the world [1]. This plant is commonly used in the food, in order that all parts are edible and nutritional, with a large source of protein, vitamins and minerals [2]. Stohs and Hartman [3] demonstrated that *M. oleifera* is completely safe to be consumed by humans and other animals.

This species is known as “the miracle tree”, because it presents incredible results in the cure of various diseases. As a result of their activities, some research began to isolate bioactive compounds from different parts of the plant to test their applications [4].

2. Results and Discussion

For didactic purposes, we divided the biological activities found in *M. oleifera* according to the plant anatomy.

The seeds of *M. oleifera* present a source as therapeutic potential. Cells of neurons pretreated with the compound glucomoringin-isothiocyanate (GMG-ITC), showed resistance to apoptotic cell death induced by H2O2, the GMG-ITC confers protection to the cytoskeleton and cytoplasmic inclusion, as well as preservation of the morphological characteristics and general integrity of the neural cells [9]. The same compound GMG-ITC, It was administered to mice with amyotrophic lateral sclerosis (ALS) and showed interference in the pathophysiological mechanisms of the development of ALS, acting in the deceleration or prevention of the disease [10]. GMG-ITC also showed the ability to inhibit signaling pathways that are commonly upregulated in cancer and immune disorders such as JAK/STAT, demonstrating a potential prevention of diseases such as cancer, inflammatory diseases and immunological disorders [11]. The seed powder used in the feeding of hypertensive rats had an anti-hypertrophic and antifibrotic effect, reduction in the level of cardiac triglycerides and increase of plasma prostacyclins, showing beneficial effect of *M. Oleifera* on the structure and cardiac function of hypertensive mice [12]. The essential oil of seeds from *Moringa oleifera* showed a potent cytotoxic activity, with reduction of cell viability of the cancer cell lines HeLa, HepG2, MCF-7, CACO-2 and L929 [13]. Microbial assays using seeds showed inhibition of the growth of the pathogenic bacteria *Staphylococcus aureus* e *Streptococcus mutans* [14].

Leaf extracts of *M. oleifera* presented a positive result for the treatment of atopic dermatitis, with the reduction of serum level of IgE and the clinical characteristics [15]. The aqueous extract of the leaf, with phytochemical compounds, was an important target in neural studies, with action of nicotine, the authors revealed that the aqueous extract was able to prevent chromatolysis, distortion of cerebellar cortical cells and neurobehavioral deficit, in mice treated with nicotine [16]. The hydroethanolic extract of the leaves showed antioxidant activity [17]. Hani, *et al.* [18] found that the leaf extract of MO, with secondary metabolites, maintained its antioxidant activity after encapsulation and that it is safe for oral consumption. The ethanoic extract from the leaves was tested for gastroprotective activity *in vivo*, the results were positive, the extract may contain active agents with gastroprotective activity and improvement of the mucus, this result aims at the use as agents of safe and potent treatments for ulcer [19]. *In vivo* study was done through an induced diet with leaf
powder, the results demonstrate a hypocholesterolemic effect, with use of 400mg/Kg of the extract prevented cholesterol elevation, triglycerides, low density lipoprotein cholesterol, malondialdehyde and the activities of alanine aminotransferase and serum aspartate aminotransferase [20]. studies have demonstrated efficacy of the ethanolic extract of leaves of MO against nephrotoxicity induced by N-Acetyl-p-Aminophenol (APAP), also known as acetaminophen, a common use of medication, it was seen the increase of the endogenous antioxidant system/enzymatic level to neutralize the oxidative stress environment (ROS). In addition presented a modulating effect on specific inflammatory cytokines in renal tissues [21]. The crude aqueous extract from the leaves of OM has antiproliferative effects against cancerous esophageal cell line, due to increased lipid peroxidation, DNA fragmentation and induction of apoptosis in these cells [22]. A toothpaste was developed from the ethanolic extract of the leaves of OM that showed a potential effect against the growth of Staphylococcus aureus, Streptococcus mutans, and Candida albicans [14], Vibrio cholerae, Vibrio mimicus and Escherichia coli [23]. Leaf extracts tested against the cancer cell lines MDA-MB-231 and HCT-8, of breast and colorectal cancer, respectively, showed a significant decrease in the cellular population of both cell lines, due to increase induction of apoptosis [24].

Using the MO flowers, was administrated the ethanolic extract to diabetic rats induced by streptozotocin. The results showed hypo and normoglycemic properties, as well as antioxidant properties, maintaining glucose homeostasis, and metabolic and enzymatic functions of the liver [25]. The flower extract of M. oleifera tested in macrophages induced by LPS suppressed the secretion and expression of NO, NF-κB, iNOS, COX-2, and of the proinflammatory cytokines TNF-α, IL-1β, IL-6, PGE2, besides increasing the production of anti-inflammatory cytokines IL-10 and IκB-α [26]. Flower extracts also demonstrated antimicrobial potential against V. cholerae and E. coli [23].

Antimicrobial tests with root extracts showed an antibacterial effect against the growth of Staphylococcus aureus and Streptococcus mutans [14], and from the pods inhibited Vibrio vulnificus V. cholerae, V. mimicus and E. coli [23]. The barks of MO presented a reduction in the cell population of the cancer cell lines MDA-MB-231 and HCT-8 [24].

4. Conclusions
Thus, Moringa oleifera presents a new perspective on the synthesis of natural products, considering the range of biological activities described for a species, as well as the ease of obtaining and using its compounds.

Conflicts of Interest
The authors declare no conflict of interest.

References and Notes
1. Leone, A.; Spada, A.; Battezzati, A.; Schiraldi, A.; Aristil, J.; Bertoli, S. Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of Moringa oleifera leaves: an overview. International journal of molecular sciences 2015, 16, 12791-12835.
2. Saini, R.K.; Sivanesan, I.; Keum, Y.-S. Phytochemicals of Moringa oleifera: a review of their nutritional, therapeutic and industrial significance. 3 Biotech 2016, 6, 203.
3. Stohs, S.J.; Hartman, M.J. Review of the safety and efficacy of Moringa oleifera. Phytotherapy Research 2015, 29, 796-804.
4. Guevara, A.P.; Vargas, C.; Sakurai, H.; Fujiwara, Y.; Hashimoto, K.; Maoka, T.; Kozuka, M.; Ito, Y.; Tokuda, H.; Nishino, H. An antitumor promoter from Moringa oleifera Lam. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 1999, 440, 181-188.
5. Choi, E.-J.; Debnath, T.; Tang, Y.; Ryu, Y.-B.; Moon, S.-H.; Kim, E.-K. Topical application of Moringa oleifera leaf extract ameliorates experimentally induced atopic dermatitis by the regulation of Th1/Th2/Th17 balance. *Biomedicine & Pharmacotherapy* 2016, 84, 870-877.

6. Sreelatha, S.; Padma, P. Antioxidant activity and total phenolic content of Moringa oleifera leaves in two stages of maturity. *Plant foods for human nutrition* 2009, 64, 303.

7. Morton, J.F. The horseradish tree, Moringa pterygosperma (Moringaceae)—a boon to arid lands? *Economic botany* 1991, 45, 318-333.

8. Mahmood, K.T.; Mugal, T.; Haq, I.U. Moringa oleifera: a natural gift-A review. *Journal of Pharmaceutical Sciences and Research* 2010, 2, 775.

9. Jaafaru, M.S.; Nordin, N.; Shaari, K.; Rosli, R.; Razis, A.F.A. Isothiocyanate from Moringa oleifera seeds mitigates hydrogen peroxide-induced cytotoxicity and preserved morphological features of human neuronal cells. *PloS one* 2018, 13, e0196403.

10. Galuppo, M.; Giacoppo, S.; Iori, R.; De Nicola, G.R.; Bramanti, P.; Mazzon, E. Administration of 4-(a-L-rhamnosyloxy)-benzyl isothiocyanate delays disease phenotype in SOD1G93A rats: A transgenic model of amyotrophic lateral sclerosis. *BioMed research international* 2015, 2015.

11. Michl, C.; Vivarelle, F.; Weigl, J.; De Nicola, G.R.; Canistro, D.; Paolini, M.; Iori, R.; Rascel, A. The chemopreventive phytochemical moringin isolated from Moringa oleifera seeds inhibits JAK/STAT signaling. *PloS one* 2016, 11, e0157430.

12. Randriamboavonjy, J.I.; Loirand, G.; Vaillant, N.; Lauzier, B.; Derbré, S.; Michalet, S.; Pacaud, P.; Tesse, A. Cardiac protective effects of Moringa oleifera seeds in spontaneous hypertensive rats. *American journal of hypertension* 2016, 29, 873-881.

13. Elsayed, E.A.; Sharaf-Eldin, M.A.; Wadaan, M. In vitro evaluation of cytotoxic activities of essential oil from Moringa oleifera seeds on HeLa, HepG2, MCF-7, CACO-2 and L929 cell lines. *Asian Pac. J. Cancer Prev* 2015, 16, 4671-4675.

14. Elgamily, H.; Moussa, A.; Elboraey, A.; EL-Sayed, H.; Al-Moghazy, M.; Abdalla, A. Microbiological assessment of Moringa oleifera extracts and its incorporation in novel dental remedies against some oral pathogens. *Open access Macedonian journal of medical sciences* 2016, 4, 585.

15. Hur, S.-s.; Choi, S.-w.; Lee, D.-r.; Park, J.-h.; Chung, T.-h. Advanced Effect of Moringa oleifera Bioconversion by Rhizopus oligosporus on the Treatment of Atopic Dermatitis: Preliminary Study. *Evidence-Based Complementary and Alternative Medicine* 2018, 2018.

16. Omotoso, G.O.; Gbadamosi, I.T.; Olajide, O.J.; Dada-Habeeb, S.O.; Arogundade, T.T.; Yawson, E.O. Moringa oleifera phytochemicals protect the brain against experimental nicotine-induced neurobehavioral disturbances and cerebellar degeneration. *Pathophysiology* 2018, 25, 57-62.

17. Vats, S.; Gupta, T. Evaluation of bioactive compounds and antioxidant potential of hydroethanolic extract of Moringa oleifera Lam. from Rajasthan, India. *Physiology and Molecular Biology of Plants* 2017, 23, 239-248.

18. Hani, N.M.; Torkamani, A.E.; Azarian, M.H.; Mahmood, K.W.; Ngalim, S.H. Characterisation of electrospun gelatine nanofibres encapsulated with Moringa oleifera bioactive extract. *Journal of the Science of Food and Agriculture* 2017, 97, 3348-3358.

19. Ijioma, S.; Nwagazi, E.; Nwankwo, A.; Oshilonya, H.; Ekeleme, C.; Oshilonya, L. Histological exhibition of the gastroprotective effect of Moringa oleifera leaf extract. *Comparative clinical pathology* 2018, 27, 327-332.

20. Helmy, S.A.; Morsy, N.F.; Elaby, S.M.; Ghaly, M.A. Hypolipidemic Effect of Moringa oleifera Lam Leaf Powder and its Extract in Diet-Induced Hypercholesterolemic Rats. *Journal of medicinal food* 2017, 20, 755-762.

21. Karthivashan, G.; Kura, A.U.; Arulselvan, P.; Isa, N.M.; Fakurazi, S. The modulatory effect of Moringa oleifera leaf extract on endogenous antioxidant systems and inflammatory markers in an acetaminophen-induced nephrotoxic mice model. *PeerJ* 2016, 4, e2127.

22. Tiloke, C.; Phulukdaree, A.; Chuturgoon, A.A. The antiproliferative effect of Moringa oleifera crude aqueous leaf extract on human esophageal cancer cells. *Journal of medicinal food* 2016, 19, 398-403.
23. Brilhante, R.S.N.; Sales, J.A.; de Souza Sampaio, C.M.; Barbosa, F.G.; Paiva, M.d.A.N.; de Melo Guedes, G.M.; de Alencar, L.P.; de Ponte, Y.B.; Bandeira, T.d.J.P.G.; Moreira, J.L.B. Vibrio spp. from Macrobrachium amazonicum prawn farming are inhibited by Moringa oleifera extracts. *Asian Pacific journal of tropical medicine* **2015**, *8*, 919-922.

24. Al-Asmari, A.K.; Albalawi, S.M.; Athar, M.T.; Khan, A.Q.; Al-Shahrani, H.; Islam, M. Moringa oleifera as an anti-cancer agent against breast and colorectal cancer cell lines. *PloS one* **2015**, *10*, e0135814.

25. Arise, R.O.; Aburo, O.R.; Farohunbi, S.T.; Adewale, A.A. Antidiabetic and antioxidant activities of ethanolic extract of dried flowers of Moringa oleifera in streptozotocin-induced diabetic rats. *Acta Facultatis Medicae Naissensis* **2016**, *33*, 259-272.

26. Tan, W.S.; Arulselvan, P.; Karthivashan, G.; Fakurazi, S. Moringa oleifera flower extract suppresses the activation of inflammatory mediators in lipopolysaccharide-stimulated RAW 264.7 macrophages via NF-κB pathway. *Mediators of inflammation* **2015**, 2015.

© 2015 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions defined by MDPI AG, the publisher of the Sciforum.net platform. Sciforum papers authors the copyright to their scholarly works. Hence, by submitting a paper to this conference, you retain the copyright, but you grant MDPI AG the non-exclusive and un-revocable license right to publish this paper online on the Sciforum.net platform. This means you can easily submit your paper to any scientific journal at a later stage and transfer the copyright to its publisher (if required by that publisher). (http://sciforum.net/about ).